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SURGICAL RESEARCH

Exploring our History - Navigating the Future

11-13 February 2022

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ACKNOWLEDGEMENT

It gives us immense pleasure to share this JPMA special supplement with our readers, published as an appurtenance to the *7th AKU Annual Surgical Conference* of the Aga Khan University, Karachi, Pakistan. The theme of the conference is 'Surgical Research: Exploring our History — Navigating the Future,' and submissions were invited keeping this theme in mind.

We are grateful for the enormous response from both national and international contributors and a total of 98 manuscripts were received. We adopted JPMA's strict criteria for publication and each submission was first evaluated for plagiarism through specialized computer software. No manuscript was rejected at this level. This was followed by coding of each submission to ensure that the peer-review process remains blinded and transparent. Each submission was then assigned to two independent reviewers, who were subject specialists belonging to the same specialty, again based on standard JPMA policy. In case of discrepancy, a statistical review or a third editorial review was also done. Complete confidentiality of the reviewers was ensured. All reviews were carried out on standard JPMA review forms. Only articles that were judged by both reviewers to be publishable in their present form; or with minor changes were selected. Articles requiring major revisions were not considered for publication.

A total of 26 articles were thus accepted for publication. This final list of articles was forwarded to JPMA for final editorial review, along with the comments of the reviewers. At this point we must mention that some of the rejected articles were actually of reasonable quality, but could not be published, on the basis that they were not related to the theme or required major revisions in either format or language, which given the short time-line, was not possible for this particular supplement.

We would also like to take this opportunity to thank our Departmental Chair: Dr. Syed Ather Enam, Conference Chair: Dr. M. Shahzad Shamim, Publication Committee: Drs. Nadeem Ahmed Siddiqui (Chair), Syed Muhammad Nazim (Co-Chair), Amber Sultan, Abdul Sami Memon, Shiraz Hashmi, Rizwan Haroon Rashid, Lubna Vohra and especially our administrative staff, Shariff Charania who worked tirelessly day and night and made this herculean task possible. We hope you will appreciate the quality of papers in this supplement.

We look forward to welcoming you all and we hope you will take an active participation in the *7th AKU Annual Surgical Conference* to be held on February 11-13, 2022.

Publication Committee
7th AKU Annual Surgical Conference
Surgical Research: Exploring our History - Navigating the Future

EDITORIAL

Surgical research: Exploring our history — navigating the future

Nadeem Ahmed Siddiqui, Muhammad Shahzad Shamim, Syed Ather Enam

In the fifteenth century, trained individuals called' barber surgeons' mastered the art of handling sharp instruments and performing basic surgical procedures. They even founded a 'United Company of Barber Surgeons' in 1540.[1] Besides shaving and haircutting, they were trained to perform dental extractions and a few surgical procedures. Later in 1745, qualified doctors and surgeons came together and founded 'Company of Surgeons' in the UK, which later became the Royal College of Surgeons in London.[2] This progression from anecdotal experiences of the guild of barbers to a formal society that helped the implementation of scientifically reasoned decisions by Royal College Surgeons was only possible because surgeons were able to appreciate the value of the evidence and incorporate it into their practices.

We are witnessing rapid advancements and refinements in surgical techniques, the evolution of surgical aids and instruments, and the introduction of safer and less invasive surgical alternatives.[3] Even surgical training has shifted from the conventional Halstedian model of apprenticeship to more competency-based training with constantly evolving modalities to improve the learning process.[4] Key to this evolution has been the surgeon's ability to generate new evidence and keep their practices in accordance with growing literature. Research in surgery has enabled the surgical community to improve healthcare quality, resulting in better outcomes of surgical diseases. Research in surgery has several inherent difficulties that make it unique when compared to other specialties, especially in conducting high-quality surgical research like randomized controlled trials.[5,6]

Due to the enormous burden of surgical disease, some low-middle income countries (LMIC)s can meet only about 3.5% of surgical procedures of their total need.[7] A few factors responsible for this disparity include poor access to surgical care, fewer centres, and fewer surgeons in these countries. Surgeons lose revenue by taking time out for research from their clinical work. Research becomes less of a priority with fewer surgeons available to deal with a high workload. Western countries excel in surgical research because of substantial financial support from government and private sectors, and this lack of financial support is another factor limiting research in LMICs.[8] In LMICs, surgeons do not have the infrastructure to support research, do not have funds to create an infrastructure, and do not get paid to do research.

There has been an overwhelming interest in standardizing practices amongst surgeons across the world. Initiatives like Global Surgery strive to address the issue of the non-availability of essential surgical procedures in LMICs, and it has started to make an impact.[9] There is a similar need for large-scale initiatives that focus on developing strong research cultures in institutions and individuals. Identifying barriers to surgical research systematically and then focusing on finding solutions to these issues is critical. We think a multi-faceted approach with clearly defined short and long-term goals will help.

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ORIGINAL ARTICLE

Bonded amalgam as a fissure sealant in low-income setting: A randomised controlled trial

Farhan Raza Khan,[1] Samreen Liaquat,[2] Ghazala Rafique,[3] Syed Iqbal Azam,[4] Arshad Hasan[5]

Abstract

Objective: To compare one year retention rate of bonded amalgam sealants (BAS) with that of conventional resin-based sealant (RBS).

Methods: It was a parallel group, equivalence, randomised controlled trial done during March 2018 to December 2019 at the dental clinics of Dow University of Health Sciences, and the Jinnah Sind Medical University, Karachi, Pakistan on children aged 12-16 years, who were randomly assigned to one of the two treatment groups (BAS vs. RBS). Complete retention of the sealant at one year follow-up was labeled as success. Multi-level mixed effect logistic regression model was employed. Study was registered at www.clinicaltrials.gov # NCT NCT03130725.

Results: There were 137 teeth (23 subjects) in the BAS and 128 teeth (15 subjects) in the RBS group that were evaluated for sealant retention at 12 months follow-up. Among the BAS group, 100/137 (73%) sealants were completely retained whereas 110/128 (86%) were fully retained in the RBS group. Nearly, 22/137 (16%) BAS and 10/128 (7.8%) RBS were completely dislodged. In multivariable analysis, subject age >15 years and male gender were found to be significantly associated with the dislodgement of sealants.

Conclusions: At 12 months follow-up, the retention of bonded amalgam sealant (BAS) was significantly lower than that of the resin-based sealant (RBS).

Keywords: Bonded amalgam sealants, Resin-based sealants, Retention, Caries.

RCT Registration: www.clinicaltrials.gov with # NCT NCT03130725.

(JPMA 72: S-3 [Suppl. 1]; 2022) **DOI: https://doi.org/10.47391/JPMA.AKU-02**

Introduction

Dental caries is a microbial disease where cariogenic bacteria living on carbohydrates produce acid that leads to dissolution of inorganic component of teeth followed by enzymatic disintegration of organic part of teeth.[1] It is one of the common conditions which people encounter throughout their life. According to global survey of 2009, on an average 70% of children were reported with dental caries in USA.[2] Untreated dental caries in children adversely affects the quality of life resulting from dental pain, causing weight loss, anorexia, sleeping problems, and changes in behaviour.[3] World Health Organization (WHO) has reported that caries rates are higher among children in developing countries compared to the children residing in developed countries. World Oral Health report 2003 revealed that high dental caries patterns were observed in Asia and America. However, countries including Australia, Russia and China had moderate caries rate.[4]

Fissure sealant is an established preventive modality against occlusal surfaces caries in posterior teeth.[5] The sealant material bonds either chemically or micromechanically to the tooth surface and forms a tight seal with the enamel surface thus prevent cariogenic bacteria from damaging the tooth structure by their acidic attack.[6] Agencies including Centre for Disease Control and Prevention (CDC), USA and American Dental Association (ADA) has recommended dental sealants for caries control in school based oral health programmes.[7] Sealant retention rate decreases over time. A systematic review and meta-analysis based on 110 reports[8] showed that 5-year retention rate of RBS is 64.7% (95% CI=57.1-73.1%).

Staninec and co-investigators studied bonded amalgam sealant and inferred that the effectiveness of BAS was like that of conventional RBS.[9] Furthermore, clinical evaluation of BAS showed that it not only prevented dental caries but in addition of being readily detectable, demonstrated low marginal leakage, lowered postoperative sensitivity and had adequate retention. It has been suggested that amalgam can be used as a fissure sealant in permanent teeth. Staninec et al. have also shown that the amalgam sealants are not only durable, but their consistency and handling characteristics are also dentist-friendly.[10]

The objective of this trial was to compare the 12 months

[1]Department of Operative Dentistry, [2]Department of Clinical Research, [3,4]Department of Community Health Sciences, Aga Khan University, Karachi, [5]Department of Operative Dentistry, Dow Dental College, Dow University of Health Sciences, Karachi, Pakistan.

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retention rate of amalgam sealants with that of resin sealants in children aged 12-16 years.

Methodology

A parallel group randomized controlled trial was done to compare the retention rate of bonded amalgam sealants with the resin-based sealants during March 2017 to December 2019. An allocation ratio of 1:1 was taken into consideration. The trial sites were the dental clinics of the Dow University of Health Sciences and the Jinnah Sind Medical University, Karachi, Pakistan. The trial protocol was registered at www.clinicaltrials.gov with # NCT NCT03130725. The CONSORT guidelines were followed for the trial.

Children aged 12 to 16 years who visited dental clinics of the two university hospitals and were willing to participate in the study were assessed for the eligibility. Children who were permanent residents of Karachi and had DMFT score of at least 2 were included in the study. Teeth were clinically assessed for the presence of cavitated carious lesions before the sealant placement. Only caries-free and completely erupted teeth were included in the study.

Participants in both study groups were given baseline education regarding the maintenance of oral hygiene using pamphlets in the local language. Oral hygiene instructions and tooth brushing technique were explained to the study participants.

We randomly assigned 51 children having 354 sealant eligible permanent molars and premolars (as shown in Figure-1) satisfying the inclusion criterion into BAS (30 children; 177 teeth) and RBS (21 children; 177 teeth) groups. Standard clinical protocol of sealant application was followed. All the sealants were placed by dentists having more than 5 years of clinical experience. Interventional product contained three ingredients: 1) Etching Unietch (37% phosphoric acid) used in semi gel form. 2) Adhesive (Adper Single Bond, 3M-ESPE, USA and 3) Sealant material (either flowable resin material (ClinPro 3M-ESPE, USA or Amalgam (Tytin spherical high copper alloy, Kerr, USA).

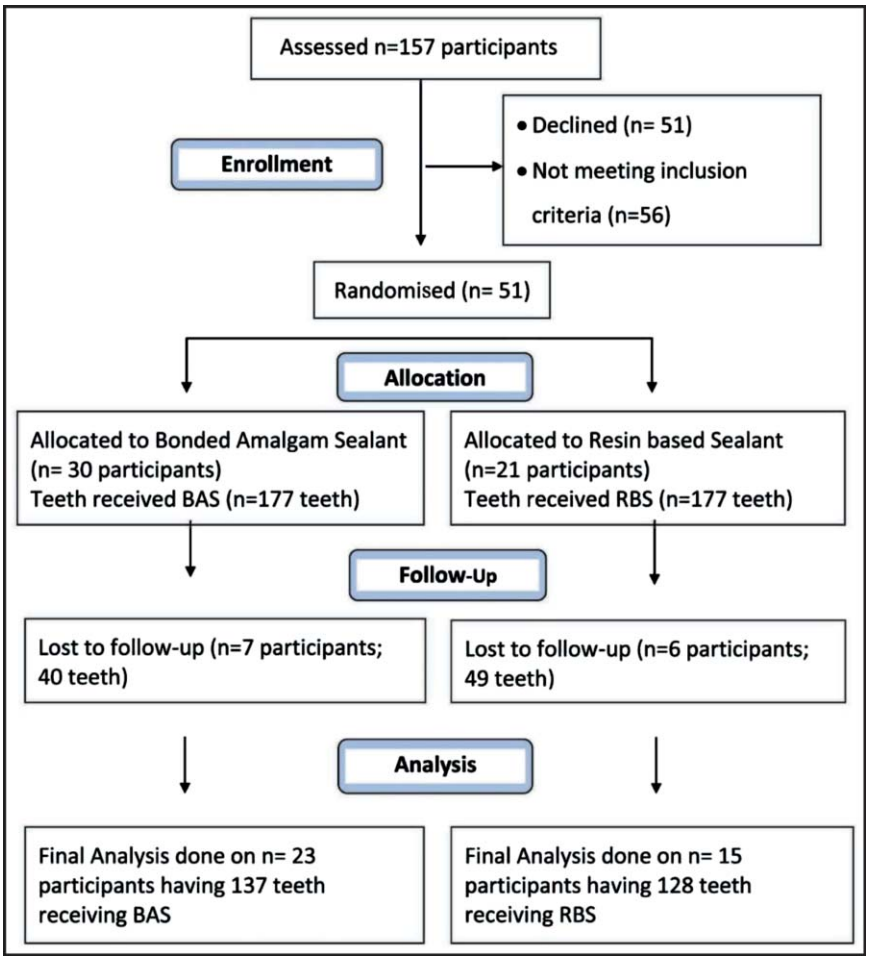

Figure-1: Study flow diagram as per CONSORT requirements NCT03130725.

For BAS, teeth were cleaned using three-in-one syringe and dried with cotton gauze and air spray. Etchant was applied on the cleaned tooth surface for 20 seconds, washed and dried with air water spray. Auto cured adhesive was applied and air thinned. Small capsule of amalgam alloy was mixed in the amalgamator and then applied directly onto the intended tooth surface. Amalgam was packed into the pits and fissure using small ball burnisher. After five minutes of initial setting time, the excess was removed using sterile cotton pellets.

The primary outcome was the retention of sealant material at 12 months follow-up (categorized into three categories: complete retention; partial retention and dislodgement). The outcome was ascertained by visual and clinical examination using mouth mirror and dental explorer. Blinding of the outcome assessor was not possible owing to the nature of intervention. Complete retention was labelled when the sealant material was found completely occupying the pits and fissures. Partial retention was

categorized when fissures were partially visible. Failure or dislodgment was considered when the fissures were completely visible.

The sample size was estimated by using NCSS PASS.[11] A total of 177 teeth in each arm were needed to achieve 5% significance level. This number provided the study an ability to detect a 30% clinical difference between groups with a power of 80 % and alpha 2.5% in each arm.

The group allocation was done using random number table. Even number last digit received BAS and odd numbers consequently received RBS. Both parties (study participants and the investigators) were aware of the treatment allocation. Owing to the physical nature of the intervention, it was not possible to conceal the treatment.

Clinical history, oral hygiene status and outcome were recorded on the study proforma by a trained dentist. Assent from the children and informed consent from the parents were obtained in Urdu language and retained for the record purpose. Patients and parents were assured that the individual level data will be kept confidential, and no personal identifiers of the participants will be disclosed. The investigators were responsible for the data monitoring, its audit and the quality.

Data analysis: Data were analyzed on SPSS 23.0. Frequency distribution of all the categorical variables (gender, maternal education, education of father, family's monthly income, frequency of tooth cleaning, method of tooth cleaning, cleaning of teeth at night, previous history of dental treatment) were determined. As data were taken at more than one level, therefore, multilevel logistic regression was used. Level of significance was kept at 0.05. Teeth characteristics were treated as primary level and patient characteristics were considered at secondary level. Tooth was taken as the unit of analysis. Missing data were excluded from the analysis. Interim analysis done at the 6 months follow-up.

Results

A total of 157 children were examined of which 106 were excluded for their unwillingness to participate or not satisfying the eligibility criteria. We selected 51 children (354 teeth) in the trial. Each participant contributed multiple teeth (on average 6-8 teeth) in the study. The study CONSORT flow diagram is shown as Figure-1.

The selected 51 participants were assigned treatment in a manner that there were 177 teeth in each treatment arm. At 12 months follow-up, seven subjects contributing to 40 teeth (22.6% data) were lost to follow up in the BAS group and six subjects contributing to 49 teeth (27.7 % data) were lost to follow up in the RBS group. Final analysis was

Table-1: Socio-Demographic characteristics of the study participants (baseline).

Variables (subject level data)	Categories	BAS (n=30)	RBS (n = 21)
Age	12 years	5(16.6%)	5(23.8%)
	13 years	7(23.3%)	5(23.8%)
	14 years	2(6.6%)	4(19.0%)
	15 years	11(36.7%)	3(14.2%)
	16 years	5(16.6%)	4(19.0%)
Gender	Male	10(33.3%)	6(28.5%)
	Female	20(66.6%)	15(71.4%)
Education of Mother	No Schooling	9(30%)	7(33.3%)
	Primary school	2(6.6%)	4(19.0%)
	Secondary school	13(43.3%)	2(9.5%)
	Intermediate	1(3.3%)	3(14.2%)
	Graduate and above	5(16.6%)	5(23.8%)
Education of Father	No Schooling/Primary school	10(33.3%)	8(19.0%)
	Secondary school	13(43.3%)	6(28.5%)
	Intermediate	5(16.6%)	2(9.5%)
	Graduate and above	2(6.7%)	5(23.8%)
Monthly Income in rupees	Less than10,000	5 (16.6%)	3(14.2%)
	10,000-15,000	12 (40.0%)	7(33.3%)
	More than 15000	12 (40.0%)	4(19.0%)
	Not known	1 (3.3%)	7(33.3%)
Ethnicity	Sindhi	8 (26.6%)	5(23.8%)
	Punjabi	1 (3.3%)	10(47.6%)
	Saraiki	1 (3.3%)	2(9.5%)
	Other	14 (46.6%)	1(4.7%)
	Urdu speaking	6 (20.0%)	3(14.2%)

n refers to the number of participants.

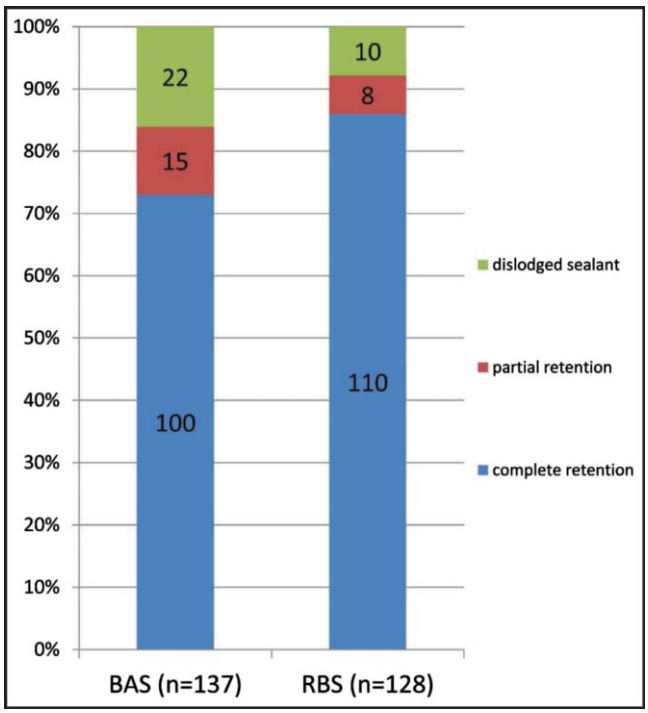

Figure-2: Retention of sealant material in the two study groups at 12 months' follow-up.

Table-2: Baseline characteristics of the participants in the treatment arms.

Variables at participant level	Categories	BAS (n = 30)	RBS (n = 21)
Previous history of dental treatment	No treatment	24 (80%)	17 (80.9%)
	Other treatments (Extraction, Filling and Pulpectomy /Root Canal)	6 (20%)	4 (19.0%)
Plaque Index	-	2.02 (0.44)	1.67 (0.54)
Method of cleaning	Once a baby brush (Manual/Electric)	27 (90%)	19 (90.4%)
	Others (Fingers, Miswaak/ Dandaas, Soft cleaning cloth, Rinsing with water)	3 (10%)	2 (9.5%)
Betel nuts	No(reference)	7 (23.3%)	6(28.5%)
	One pack/day	6(20%)	3(14.2%)
	Two pack/day	8(26.6 %)	3(14.2%)
	Three pack/day	2(6.7%)	2(9.5%)
	More than three pack/day	2(6.7%)	5(23.8%)
	Rarely	5(16.7%)	2(9.5%)
Dietary consumption	No Bar/Day (reference)	3 (10%)	6 (28.5%)
Chocolate	Daily Intake	27(90%)	15 (71.4%)
Ice cream	No ice cream/Daily (reference)	5 (16.7%)	7 (33.3%)
	Daily Ice cream eater	25 (83.3%)	14(66.6%)
Sweets	No sweets/day (reference)	4 (13.3%)	5(23.8%)
	Daily sweets eater	26(86.6%)	16(76.2%)
	No drinks/daily (reference)	16(53.3%)	8(38.1%)
Drinks	Yes/daily	14(46.7%)	13(61.9%)
	No burger/daily (reference)	11(36.7%)	5(23.8%)
	Yes/daily	19 (63.3%)	16(76.2%)
Burger	No pizza/daily (reference)	21(70%)	11(52.3%)
Pizza	Yes pizza/daily	9 (30%)	10 (47.6%)
Medicine	No (reference)	27 (90%)	19 (90.5%)
	Yes	3 (10%)	2 (9.5%)
Fluoride toothpaste	Yes (reference)	19 (63.3%)	18 (85.7%)
	No	11 (36.7%)	3 (14.3%)
Fluoridated water use	Yes (reference)	26 (86.7%)	15 (71.4%)
	No/Don't know	4 (13.3%)	6 (28.6%)

n refers to the number of participants.

Table-3: Risk factors affecting retention using Crude Odds Ratio with 95% Confidence Intervals.

	Factor	Crude Odds Ratio (95% CI)	Model 1	Model 2	Model 3
Group	RBS (ref)	1	1	1	1
	BAS	0.57 (0.34,0.95)	0.57 (0.34,0.95)	0.54 (<0.01,175.64)	0.56 (0.37, 0.95)
Gender	Male (ref)	1	1	1	1
	Female	0.027 (0.003, 0.20)	0.02 (0.003,10.19)	0.024 (0.001, 0.20)	0.012 (0.001, 11.28)
Age	12 years (ref)	1	1	1	1
	13 years	0.89 (0.37, 2.39)	0.89 (0.33,2.39)	0.83 (0.32, 2.4)	0.82 (0.16,4.22)
	14 years	1.08 (0.34, 3.42)	1.08 (0.34,3.42)	1.09 (0.56,3.9)	1.14 (0.17, 7.30)
	15 years	0.28 (0.11, 0.69)	0.28 (0.115,0.69)	0.29 (0.111, 0.75)	0.11 (0.003, 3.45)
	16 years	3.08 (0.74, 2.82)	3.08 (0.74,12.82)	3.5 (0.85, 3.8)	5.31 (0.35, 79.17)
Frequency of teeth cleaning	Once/day (ref)	1	1	1	1
	Twice a Day	0.83 (0.50, 1.39)	0.83 (0.50, 1.39)	0.82 (0.28,2.41)	0.83 (0.048,14.3)
Plaque index		1.75 (1.10, 2.78)	1.75 (1.10,2.78)	2.25 (0.41,12.20)	2.25 (0.41, 12.2)
Chocolate	No (ref)	1	1	1	1
	Regular intake	1.69 (0.92, 3.06)	1.03 (0.57,1.86)	1.76 (0.058, 53.29)	1.75 (0.10,29.32)
Ice cream	No (ref)	1	1	1	1
	Regular intake	1.03 (0.57, 1.86)	1.03 (0.57, 1.86)	1.04 (0.53, 2.02)	1.04 (0.45, 2.39)
Fluoride in water	No (ref)	1	1	1	1
	Yes	3.61 (1.49, 8.74)	3.61 (1.49,8.74)	3.85 (1.29, 8.8)	3.17 (0.008,16.06)
Hypo- mineralized tooth	No (ref)	1	1	1	1
	Yes	0.071 (0.009,0.532)	0.71 (0.009, 0.53)	0.064 (0.01, 2.1)	0.064 (0.002, 19.23)
Use of medicines in childhood	No (ref)	1	1	1	1
	Yes	0.59 (0.19, 1.80)	0.59 (0.19, 1.80)	0.57 (0.17, 2.2)	0.58 (0.001, 28.2)

done on 38 participants (Figure-1). Frequency distribution of the participants in the two groups are shown in Tables 1 and 2.

There were 137 teeth (23 subjects) in the BAS and 128 teeth (15 subjects) in the RBS group that were evaluated for sealant retention at 12 months from placement. Complete retention of sealants was observed in 100/137 (73%) in BAS and 110/128 (86%) in the RBS group. Partially retained sealants were observed in 15/137 (11%) and 8/128 (6.2%) teeth in BAS and RBS, respectively. Regarding failures, 22/137 (16%) in BAS and 10/128 (7.8%) in RBS were completely dislodged (Figure-2).

Following variables were significant at the bivariate analysis: type of sealant, age of child, gender, tooth brushing frequency, consumption of ice creams and chocolates etc. Presence of fluoride in water and presence of hypo-mineralized teeth were negatively associated with the sealant retention. Moreover, the use of childhood medicines was also statistically significant (OR=0.59; 95% CI: 0.19-1.80).

All independent variables were retained in the statistical model to determine association between the independent variables and the outcome. Initially three models were made. First model had tooth level variables, second model included patient level characteristics whereas the third model was constructed by including both the teeth and participant level variables (Table-3). At combined level, the main exposure (BAS vs. RBS) had no effect over the retention of the sealant. (OR= 0.56; 95% CI: 0.37- 0.95).

Discussion

The present study showed significantly inferior retention at 12 months follow up of BAS compared to RBS. There were 22/137 (16%) sealant failures in the BAS group compared to 10/128 (7.8%) in the RBS (Chi-square p-value 0.03). It's interesting to note that there was no significant difference in the retention of two sealants in the first six months. However, with time, a substantial proportion of BAS experienced dislodgment from the tooth surface. This could be due to deterioration of the bond between the adhesive resin and the silver alloy particles.

Staninec[10] has shown that in terms of retention, BAS is comparable to RBS (mean difference of only 0.08). Staninec's five-year long clinical trial also demonstrated that both RBS and BAS are retentive.[11] However, in the present study, one year follow-up showed that BAS had only 100/137 teeth (73%) with retained sealant. This was not at par with the RBS 110/128 teeth (86%). This difference could be attributed to poor isolation technique (cotton wool roll isolation) employed in the present study as no additional funding was available for rubber dam. Another explanation could be poor bonding of amalgam alloy with the adhesive.

For RBS, the present study showed 86% retention. This is similar to other studies. Mejare and Mjor[12] conducted a clinical trial to compare the retention of RBS and reported retention rate of over 90%. Poulsen et al.[13] too have reported a retention rate of >82% for RBS.

Llodra et al. studied the factors that could influence the clinical effectiveness of sealants. They observed sealants retention was high in areas supplied with fluoridated drinking water.[14] Our findings are also somewhat similar to their results as we too observed a positive effect of fluoridated water consumption as well as use of fluoridated tooth paste with the sealant retention (Table-2). In our study, females experienced more sealant dislodgment. Biologically, there is no clinical plausibility for such an observation. Such statistical significance might have resulted due to sampling errors as there were unequal numbers of participants in the two treatment groups. Folke et al. has also reported an insignificant association of gender with the sealant retention.[15]

Other possible reasons behind low sealant retention (particularly in the BAS) may be due to dietary factors. Most children in the study sample were not taking healthy diet. Consumption of betel nut and other abrasive food items were common in children of low socio-economic status in South Asian culture. All participants in the present study were mainly from the low socio-economic stratum (SES). It's known that people with low SES usually have high unemployment, increased family size and poor oral hygiene.[16] Other possible reasons behind poor retention of sealants could be that each participant contributed to multiple teeth in the sample. Moreover, a universally agreed upon definition of sealant retention is not there in the dental profession, therefore, for the study, we used the sealants retention guidelines advised by Deery.[17]

The lost to follow up in the present study were 7 participants; 40 teeth (22.6% data) in the BAS and 6 participants; 49 teeth (27.7% data) in the RBS groups, respectively. The differential attrition in the two groups could lead to difference in the retention rates for the study groups. In the present study, BAS fails to demonstrate its efficacy against RBS. However, with 73% retention at twelve months follow-up, BAS still can be used in management of incipient caries among high-risk children.

Use of amalgam sealants in resource restraint populations can reduce the cost burden of treatment, as amalgam is cheaper compared to RBS. Moreover, it's readily detectable on the tooth surface; a characteristic that can be useful in community-based surveys.

The present study was the first study one on amalgam sealants in south Asia. Using amalgam sealants paves the way of low-cost solution of dental caries management. The untreated dental caries may later need expensive treatments such as fillings or endodontic therapy. A considerable proportion of population in developing countries is unable to financially afford this treatment. This creates room for the use of amalgam sealants. However, this needs to be looked again in the context of the Minamata Treaty[18] which aims at reducing the release of mercury into the environment. The treaty advocates a phase-down in the use of amalgam. However, the domestic circumstances of each country and especially the economic position of the developing countries should be considered before following the legislation on such accords.

An established limitation of the present study is the lack of blinding of the data collector and data assessor. Due to nature of the intervention, all parties were ought to be aware of the treatment allocation. The clinical relevance of this study is that the resin-based sealants are commonly used for the prevention of pits and fissures caries and arresting incipient carious lesions. However, due to the cost of resin-based sealants, many children in the third world countries remain untreated. Amalgam sealants although are inferior to RBS with respect to retention, can still be employed as a viable option for these children. Amalgam based sealants are cost- effective and can be used as a dental public health intervention in the low-income populations.

Conclusions

At six months evaluation, the retention of both sealants was comparable. However, at 12 months follow-up, the retention of bonded amalgam sealant (BAS) was significantly lower than that of the resin-based sealant (RBS).

Ethics Approval: All procedures performed in the present study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The reference of Ethics review committee of the Aga Khan University was #4445-CHS-ERC-16. The reference of institutional review boards of the Dow University of Health Sciences (IRB-989/DUHS/2018/128) and the Jinnah Sind Medical University (F.2-81/2017-GENL-IRB/4521/JPMC).

Informed Consent: Informed consent was obtained from all parents/guardians of participants included in the study. We obtained the informed consent from the study participants in native language (Urdu).

Disclosure and Consent to Publish: Some of the data in the present paper was presented at MSc of Dr Samreen Liaquat. However, the one-year data were never shared, presented or published elsewhere. All authors have expressed their consent to publish.

Disclaimer: The AKU-URC grant covered dental materials, consumables and equipment needed for placing amalgam sealants and resin-based sealants but did not cover the procedure fee that is charged at the dental clinics. Hence, it was decided to carry out the trial at the public sector dental institutions (Dow Dental College and JSMU) where there is no separate fee for procedures. Therefore, IRB approvals from DUHS and JSMU were also taken after AKU-ERC approval. Dr Arshad Hasan did the oversee of the trial outside AKUH.

Conflict of Interest: All authors declare that there is no conflict of interest regarding this paper.

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RESEARCH ARTICLE

Manual loop in laparoscopic appendectomy: A retrospective cohort study and literature review

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Abstract

Objective: To determine the incidence of complications [Surgical site infection (SSI), intra-abdominal abscess (IAA), stump leak] related to stump ligation with manual loop of sliding extracorporeal suture knot in laparoscopic appendectomy.

Methods: This cohort study was conducted on patients who underwent laparoscopic appendectomy from June 2014 to November 2020 performed by the same surgeon with almost similar technique. Stump was ligated with manual loops, applied by the surgeon or trainee or both (one by surgeon and other by trainee). SSI and IAA were classified according to Centers for Disease Control and Prevention (CDC) criteria.

Results: Total 120 patients were included with median (Interquartile range, IQR) age of 24 (19-35) years and male predominance i.e. 81 (67.5%). Median (IQR) for the duration of symptoms, time from presentation to surgery and duration of surgery was 2(1-4) days, 10 (4-15) hours and 60 (44-70) minutes, respectively. SSI was documented in 9(7.5%) patients, managed by wound hygiene and antibiotics. IAA was observed in one(0.8%) patient who required readmission for antibiotics and radiology guided drain placement. No stump leak was observed.

Conclusion: Manual endo-loop is a safe, reliable and cost effective technique for stump ligation in LA, and can safely be incorporated into teaching of surgical trainees.

Keywords: Surgical Site Infection, Intra Abdominal Abscess, Endoloop, Stump leak, Clips, Stapler.

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Introduction

Acute appendicitis is a common abdominal emergency dealt by general surgeons[1] with cumulative incidence of 7% in general population.[2] Appendectomy is the standard of care. First reported[1] by a German gynecologist Kurt Semm in 1983, laparoscopic appendectomy (LA) has been gaining widespread acceptance due to various reasons i.e. accurate diagnosis, less morbidity and early return to activity. However, the main limiting factors are the equipment (availability & cost), learning curve and surgeons' resistance to acquire a new technique.

Apart from the laparoscopic equipment; trocars (if disposable), energy devices and ligation of the base of appendix determine the cost of treatment. Reusable metallic trocars and bipolar devices can curtail much of the cost. The stump can be dealt with any one of the several ways like staplers, clips (titanium, Hem-o-lok), commercial endo-loop, manual loop, intracorporeal ligation, extracorporeal sliding knot, bipolar cautery and ligasure. The decision of choosing any one of these tools is based on several factors i.e. reliability, cost, technique, duration of surgery and applicability to distended appendix.[3] In a meta-analysis by Antoniou et al.,[4] suture ligation was found superior to others.

Since presently, LA is the first step of a surgical trainee in the world of minimally invasive surgery; a mentor/ supervisor has to be vigilant about patient safety and cost. In general, one commercial endo-loop is applied at the base of appendix and supervisor feels comfortable in applying it with himself / herself to avoid a leakage. If one extra endo-loop is applied for the training purpose, it would increase the cost and poses an ethical dilemma. Hence, a manual loop can serve that purpose, where more than one manual loops can be prepared from a single polyglactin (vicryl) suture. Manual loop has been compared to commercial endo-loop with no significant difference in morbidity.[5] This improves the knotting technique as well as hand eye coordination of the trainee while applying the loop and also encourages the mentor to train the future surgeon without additional cost and concerns.

The objective of this study was to determine the incidence of complications (SSI, IAA, stump leak) after appendiceal stump ligation with manual loop of sliding extracorporeal suture knot in laparoscopic appendectomy at a tertiary care hospital.

Patients and Methods

This cohort study was conducted at the Department of

[1,3-6]Department of General Surgery, Patel Hospital, Karachi, [1]Department of Neurosurgery, Liaquat National Hospital, Karachi, [2]Department of Urology, Aga Khan University Hospital, Karachi, [5]Department of Surgery, Dr. Ruth K. Pfau Civil Hospital, Karachi, Pakistan.

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General Surgery, Patel Hospital Karachi, Pakistan. Patel hospital is 200 bedded; not-for-profit tertiary care hospital and an academic institution with post graduate programme in general surgery and other disciplines. Patients (12 years and above) who underwent LA between June 2014 and November 2020 were included in the study. Exclusion criteria was: a) LA with stump closure other than manual extracorporeal suture knot i.e. intracorporeal knot, stapler or clip; b) conversion to open; c) other concomitant abdominal surgery; d) any other pathology encountered during surgery; e) lost to follow up.

After the approval by Ethical Review Committee of Patel Hospital Karachi in May 2016, the data collection commenced and had to be continued till December 2020 in order to collect a substantial number of cases. The data of the patients i.e. demographics, operative details, histopathology and clinic follow up were maintained in the HIMS (Hospital Information management System) and intermittently recorded on a proforma by surgical residents.

The cases were performed under general anaesthesia by the same general surgeon with almost a uniform technique. Patient was asked to void just before the procedure. Ceftriaxone (3rd general cephalosporin) was used in majority of patients. After skin preparation with povidine iodine, a 10-mm optical port was inserted above the umbilicus, followed by a 5-mm port in the suprapubic midline region. The second 10-mm port was inserted either in the midway between the first 2 ports and to the left of the rectus abdominis muscle in left iliac fossa or in right upper quadrant, depending on the body habitus. Patient was placed in Trendelenburg's position with leftward tilt and terminal ileum was swept medially. Appendix was located by either following the ligament of Traeves or taeniae coli. Depending on the variety of findings, the meso-appendix was dealt with combination of blunt dissection, diathermy and clipping. The manual loop with extracorporeal knot on '0' size polyglycolic acid (Vicryl) suture was prepared by surgeon or trainee as shown in Figure-1. A trainee had to practice the knot till the knot preparation time was within 20 seconds. Manual loops (upto three in number) were applied either by the surgeon or trainee or both (one by surgeon and other by trainee).

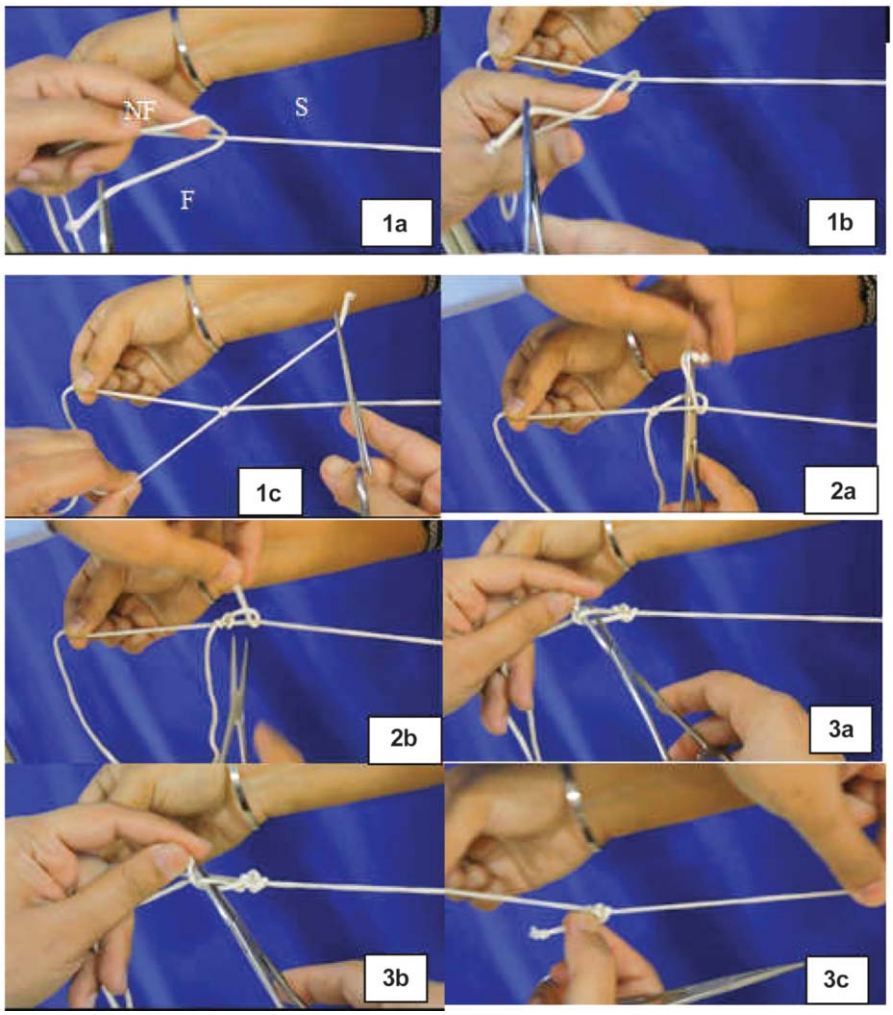

Figure-1: Showing the steps of manual endo-loop formation.
Step 1 a-c: Assistant holds the suture straight and taught (S) with two hands. The surgeon loops the free end of suture around S to create a complete knot between Non Functional (NF) and Functional (F) segments of suture with the help of a fine artery forceps.
Step 2 a and b: The surgeon throws two more knots of F around S.
Step 3 a-c: The surgeon throws two knots of F around NF and tightens to secure all the previous knots. The surgeon then checks the knot adequacy by sliding it over S.

Suture knot was pushed via port through a fascial dilator (14F, 25cm, Boston Scientific) or Johan forceps. First loop was tightened around the base of appendix, approximately 2-5mm distal to cecum, with a slow and steady pressure till the appendicular tissues started blanching. In most of the cases, one more loop was applied

few millimeters distal to the first one. After transacting the appendix above the sutures, specimen was withdrawn into the 10 mm port and retrieved out of the body. If the specimen was too thick to be retrieved via 10mm port, a glove bag was used to retrieve it after dilating the optical port. Wounds were closed with vicryl 3-0 subcuticular or prolene 3-0 interrupted vertical mattress sutures.

Post operatively, patients were kept nil per os upto 6-24 hours depending on the findings and the course. Antibiotics were discontinued after two post-operative doses in clean cases or continued for three post-operative days in contaminated or dirty cases with frank pus or perforation or gangrene. Daily surgical sites were assessed by the registrar of surgery and/or consultant surgeon till discharge from hospital. Patients were discharged once they were mobilized, passed flatus/stool and tolerated soft diet. After discharge, there was a weekly follow up at the outpatient clinic by the consultant surgeon till the wounds healed completely. If SSI was found in closed wounds, the sutures were removed, daily dressing was done either by the patient, family or a visiting home health care provider till the wound healed completely.

The primary outcome variable was intra-abdominal abscess (IAA) or stump leak. IAA labelled if the patient had persistent fever >100° F, abdominal tenderness, diarrhoea or ileus (vomiting, constipation, abdominal distension and absent bowel sounds); and ultrasound or CT scan reported a fluid collection. Leak was labelled if contrast study (CT scan or follow through) confirmed the stump leak or if stump leakage was confirmed on re-exploration.

The secondary outcome variables were SSI and duration of surgery. SSI was assessed according to criteria of the Centers for Disease Control and prevention (CDC)[6], within a period of at least 30 days postoperatively. Duration of surgery was recorded as time from incision to dressing.

Data was checked for wild codes and internal consistency with frequency tables and cross tabulations. Continuous variables were analyzed as means ± standard deviation for data with normal distribution and median with inter-quartile ranges for skewed data. Categorical variables were analyzed as proportions and percentages.

Results

Total of 120 patients were included in the study (Figure-2) with median (Interquartile range, IQR) age of 24 (19-35) years and male predominance i.e. 81 (67.5%). Median (IQR) for the duration of symptoms, time from presentation to surgery and duration of surgery was 2(1-4) days, 10 (4-15) hours and 60 (44-70) minutes, respectively (Table-1) Median (IQR) hospital stay was 1 (1-2) days. Average time required to prepare a manual loop was 20±1.9 seconds.

Table-1: Summarizes the baseline and outcome variables of the study cohort (n=120).

Baseline variables	
Age (years)[1]	24 (19-35)
Male gender	81 (67.5%)
Onset of symptoms (Days)[1]	2 (1-4)
Mode of diagnosis	
Clinical	44 (36.7%)
Clinical+ultrasound	38 (31.7%)
Clinical+CT scan	38 (31.7%)
Presentation to start of surgery (hours)[1]	10 (4-15)
Free fluid	
No	67 (55.8%)
Clear/amber	22 (18.3%)
Purulent	29 (24.2%)
Haemorrhagic	2 (1.7%)
Perforation	15 (12.5%)
Gangrene	13 (10.8%)
Adhesions	
No	44 (36.7%)
Flimsy	41 (34.2%)
Dense	35 (29.2%)
Time for manual loop formation[2]	20±1.9 seconds
Number of manual loops	
Single	20 (16.7%)
Double	96 (80%)
Triple	04 (3.3%)
Wound closure	
Interrupted, non absorbable suture	90 (75%)
Subcuticular, absorbable sutures	30 (25%)
Duration of Surgery (minutes)[1]	60 (44-70)
Final histopathology	
Normal Appendix	1 (0.8%)
Acute appendicitis	114 (95%)
Obliterated lumen, fibrosed appendix	2 (1.7%)
Follicular hyperplasia	3 (2.5%)
Outcome variables	
Superficial SSI	9 (7.5%)
Intra-Abdominal Abscess	1 (0.8%)

[1]Median (inter quartile range). [2]Mean±Standard deviation.
SSI=Surgical site infection.

Nine out of 120 patients developed complications. SSI was documented in 9(7.5%) patients in supra-umbilical port, managed by wound hygiene and antibiotics. One patient, who had perforated appendix with purulent fluid around it, developed SSI as well as IAA at 6th post-operative day. CT scan with oral and intravenous contrast confirmed the IAA without a stump leak, that was managed by radiology guided drain placement. He was readmitted due to a need for intravenous antibiotics (Piperacillin/tazobactam) to cover multi drug resistant

Table-2: Summarizing studies on different methods of stump closure in laparoscopic appendectomy.

Study	Groups (sample size)		Complications		Operative time (minutes)		Leak/abscess	
	A	B	A	B	A	B	A	B
Arcovedo et al.[20] (2007) Retrospective	Manual Loop (63)	Stapler (63)	13 (20.6%)	11(17.4%)	77	50	1	0
Yildiz et al.[5] (2009) Prospective	Manual Loop (57)	Endo-loop (41)	2 (3.5%)	3 (7.3%)	44	43	0	0
Sahm et al.[17] (2011) Prospective	Endoloop (1670)	Stapler(46)	--	--	47	76	27 (1.6%)	1(2.2%)
Ates et al.[13] (2012) RCT	Intracorporeal knot tying (31)	Titaneum clip (30)	4 (13%)	6 (20%)	62	41	1	0
Hue et al.[8] (2013) Retrospective	Endoloop (66)	Haem-o-lock (39)	2 (3%)	1(2.5%)	NA	NA	0	0
Rakic et al[6] (2014)	Endoloop (229)	Stapler (104)	13 (5.6%)	11(10.5%)	48	55	5 (2.1%)	3 (2.8%)
Luchi et al.[10] (2017) Retrospective	Endoloop (158)	Haem-o-lcok (121)	2 (1.2%)	3 (2.4%)	40	36	0	0
Our Study (2020)	Manual Loop (120)	-	9 (7.5%)	-	60	-	1 (0.8%)	-

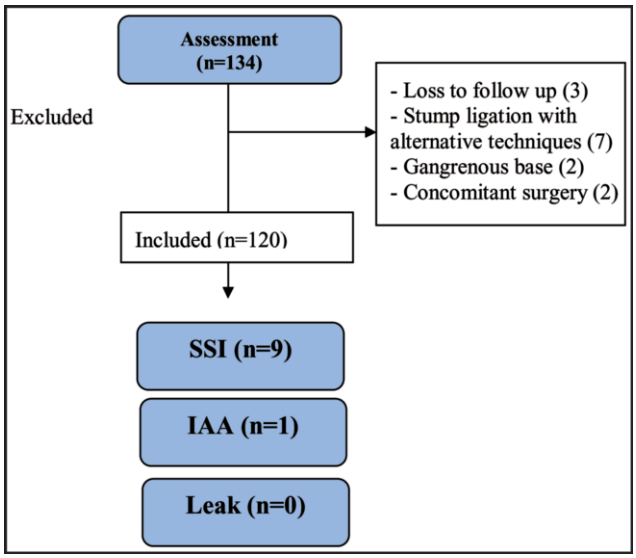

Figure-2: Flow diagram of the patients.

organism. Stump leak was not encountered in any of the patients.

Discussion

In this study, SSI was observed in 7.5% patients after LA with manual loop and IAA in only one patient; neither stump leak nor re-operation was reported in any of the patients; thus, reiterating the safety and cost effectiveness of manual loop

In LA, there are several ways of closing the base of appendix. Different variables are to be considered while choosing the best technique i.e. safety, applicability, duration, reliability and cost. Stapler is easy to use, has the least complications of all and applicable to inflamed appendiceal base; however, the cost limits its utility in most of the healthcare systems.[6,7] Besides, it requires a 12mm port to apply the stapler, which is more costly and painful than a 5mm port. On the other hand, hem-o-lock clips are feasible and cost effective;[8-10] however, in these studies the patients with wide base were ligated with alternate techniques like stapler or endo-loop and excluded. Hue CS et al found that hem-o-loks are unsafe for severely inflamed appendiceal base >10mm,[8] where it increases the risk of pressure necrosis and leak owing to forceful application to lock the clips.

Titanium clips (TC) are also investigated with results comparable to the suture ligation;[11,12] however, possess the same drawback of hem-o-lock clips especially in a distended, thickened or friable appendix. In the light of a prospective study, the average size of the base of appendix in acute appendicitis was 12mm (ranging from 6 to 23 mm); the authors suggested use of Hem-o-lock or TC for small diameter and endo-loop or staplers for wider ones. Another factor is slippage of TC reported by Ates et al.[13] in a patient with repeated abdominal pain following LA. They also reported one patient with IAA and re-exploration with intact stump in TC group.

In a systematic review, suture ligation was considered superior to other techniques for stump closure.[4] The suture ligation can be performed with any of these techniques i.e. intra-corporal knotting, needle invagination, commercial endo-loop and manual loop. For the safety and cost effectiveness, Kiudelis M[14] stated that intra-corporeal invagination is cheaper than endo-loop but it increases the duration of surgery. Also it requires expertise of intra-corporeal knot tying and the pressure of knot varies from person to person i.e. it may be too tight a knot to cut through the tissues or a loose knot that makes the stump prone to leak.

The manual loop requires a short period of training and its application is smooth and controlled. The knot does not loosen after application and can be applied to any type and size of appendix as shown in our study. It requires an average of 20±1.9 seconds to prepare a knot. One commercial endo-loop costs around 80 USD and applying two loops means 160 USD. On the other hand, one vicryl suture is around 4USD and as many as four loops can be prepared from a single suture. Therefore, manual loop is a

safe, reliable and cost effective technique of stump closure[5,15-17] with a negligible rise in operative time i.e. 40 seconds for two loops in our study. Moreover, these manual loops can also be used in other areas i.e. gallbladder, fallopian tube.

Manual loop can be slipped through several instruments i.e. through the fenestrated prongs of Johan forceps,[18] a fascial dilator or laparoscopic metallic knot pusher. We used one fascial dilator in as many as 10 cases after re-sterilization with ETO (Ethylene Oxide) or CIDEX (Activated Glutaraldehyde). One possible reservation would be a theoretical risk of SSI following reuse of a disposable fascial dilator. We observed Superficial SSI in 7.5% patients, which is well within the range reported in a systematic review on appendectomy.[19] However, if a new disposable 14 F fascial dilator is used every time, it would cost 3-5 USD per case; which is still much lower vis-à-vis commercial endoloops.

As the strengths of this study, all the procedures were performed and followed by a single surgeon with a uniform technique and postoperative follow up. The data from June 2014 to May 2016 was collected retrospectively after ERC approval, while the data collection continued till December 2020 to collect a substantial number of cases. The limitation of the study was not having calculated the sample size according to statistical methods. However, a multi-center and effectiveness randomized controlled trial, adequately powered by a priori sample size calculation, having direct comparison of manual loop with commercial endo-loop, and involvement of various surgeons and trainees at different levels is required to reach at an evidence based conclusion and recommendation.

Conclusion

In conclusion, the stated facts, figures and logical reasoning corroborate that almost all the methods of stump closure are safe and effective. However, manual loop is additionally cost effective, reproducible, trainee friendly and readily available tool. These qualities encourage a surgeon to adopt it in the day to day practice as well as teach and train without any additional cost of healthcare or risk to the patient.

Highlights

- Manual loop is safe, cost effective, trainee friendly and reproducible tool to secure appendicular stump in Laparoscopic appendectomy.

It encourages a surgeon to adopt it in the day to day practice as well as teach and train without any additional cost of healthcare or risk to the patient.

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RESEARCH ARTICLE

Temporary epicardial pacing wires in isolated Coronary Artery Bypass Graft: Necessity or force of habit?

Mian Mustafa Kamal,[1] Abdul Ahad Sohail,[2] Majid Osman,[3] Shiraz Hashmi,[4] Muhammad Mehdi,[5] Asma Altaf Hussain Merchant,[6] Muhammad Musaab Munir,[7] Hasanat Sharif[8]

Abstract

Objectives: To determine the frequency of Temporary epicardial pacing wires usage and its predictors in the immediate postoperative period in isolated coronary artery bypass graft surgery.

Method: The longitudinal study was conducted at the Aga Khan University Hospital, Karachi, from September 2019 to August 2020, and comprised adult patients of either gender who underwent isolated coronary artery bypass graft in the Department of Cardiothoracic Surgery. Demographic, peri-operative and post-operative Temporary Epicardial Pacing Wires use data was extracted from patient's files and the institutional electronic database. Logistic regression models were built to explore predictors of Temporary epicardial pacing wires usage. Data was analysed using SPSS 22.

Results: Of the 322 cases evaluated, 27(8.4%) required the use of Temporary Epicardial Pacing Wires. Mean age of the patients requiring temporary epicardial pacing wires was 66.3±8.9 years compared to 58.7±8.9 years in those who did not require it ($p<0.001$), while the left ventricular ejection fraction percentage was 44.1±12.8 and 48.9±12.8 respectively ($p=0.032$). After adjusting for clinically plausible demographics and peri-operative variables, increasing age and low left ventricular ejection fraction were significantly associated with the use of temporary epicardial pacing wires in post-operative period of isolated coronary artery bypass graft patients ($p<0.05$).

Conclusions: The frequency of temporary epicardial pacing wires usage in the post-operative period of coronary artery bypass graft was found to be low.

Keywords: Arrhythmias, Adult cardiac surgery, Electrodes, Post-operative, Temporary Epicardial pacing.

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Introduction

Temporary epicardial pacing wires (TEPWs) are placed routinely during coronary artery bypass graft (CABG) surgery for treating arrhythmias post-operatively.[1,2] They are used peri-operatively to optimise cardiac output by maintaining the rate and rhythm of the heart. Arrhythmias are common post-CABG due to transient damage to conduction tissue during the operation,[3,4] reported to be 4-58% in isolated CABG patients.[5] TEPWs are implanted on the right atrium (RA) and/or the right ventricle (RV) of the heart to provide a low resistant pathway between external temporary pacemaker and heart's surface for pacing (Figure). Most common indication for the use of TEPWs is bradyarrhythmia i.e., heart rate <50/minute, and other indications include atrioventricular (AV) blocks, asystole, junctional tachycardia, ventricular tachycardia, Type-A atrial flutter and atrial fibrillation. TEPWs are removed prior to discharge by gentle trans-cutaneous traction.[6]

While TEPWs have life-saving advantages, its use also incorporates several risks. Literature has shown the incidence of major complications related to its use to be 0.04-0.4%,[7,8] and these occur during the implantation or removal of the wires or when they are intentionally or unintentionally left inside.[9] During implantation, they tend to increase both cost and duration of the surgery, additionally having the possibility to cause laceration of the heart chambers, leading to severe haemorrhage.[1] During the removal of these wires there can be major complications, like atrial or ventricular laceration and injury to conduit grafts, leading to cardiac tamponade, which can result in life-threatening situations.[8] TEPWs, when unable to be removed, are cut flush with the skin, and, hence, a small part of it is intentionally left in the mediastinum that can lead to complications, like mediastinitis, arrhythmias and migration into nearby structures.[10]

Post-operatively, frequency of TEPW usage to pace the heart is very low. Bethea et al.[1] reported it to be 8.6%, while Asghar et al. found it to be 2.9%.[11] Both these studies identified some characteristics of the patients needing pacing wires, like increased age, diabetes mellitus, requirement of intra-operative pacing, anti-arrhythmic drugs and history of pre-operative arrhythmias.[1,11] Multiple studies have emphasised on the selective placement of TEPWs in isolated CABG rather than prophylactic placement in all CABGs. Because of its low frequency of usage and its association with major

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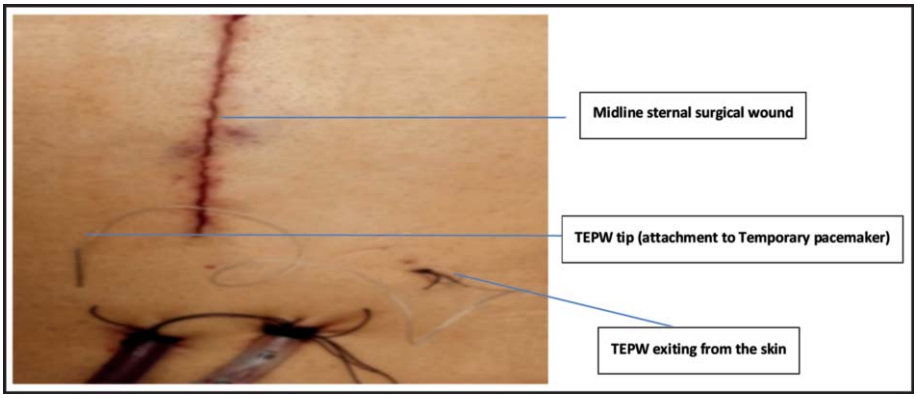

Figure: Temporary Epicardial Pacing Wire (TEPW) exit site post-operatively.

catastrophic complications, the placement of TEPWs in every isolated CABG is controversial. The current study was planned to determine the frequency and associated complications of TEPW usage in the post-operative period of isolated CABG patients, and to explore the predictors of TEPW usage.

Patients and Methods

The prospective observational study was conducted at the Aga Khan University Hospital (AKUH), Karachi, from September 2019 to August 2020. Since there was no direct interaction with the patients and all records were extracted from their files/electronic database, an exemption from ethical review committee was sought. The sample size was calculated using National Council for the Social Studies (NCSS) Power Analysis and Sample Size (PASS) version 17.0.3.[12,13] To detect a change in R-Squared of 0.31 attributed to at least 10 independent variables using an F-Test, power was kept at 80% and significance level 0.05 to detect an odds ratio of 1.5.[14] The sample was raised using non-probability consecutive sampling technique from among adult male and female patients undergoing either isolated elective or urgent CABG at the AKUH Department of Cardiothoracic Surgery. Those having pre-operative permanent pacemaker in place, undergoing off-pump, emergency or salvage CABG, and patients undergoing CABG in conjunction with some other procedures were excluded.

CABG was done via full median sternotomy and on cardiopulmonary bypass (CPB). Myocardial protection was achieved with anterograde blood cardioplegia and topical cooling of the heart. On CPB, 34 C systemic cooling was achieved, and mean arterial pressure (MAP) was kept between 70-80mmHg. All patients received RV pacing wire and additional RA pacing wire on surgeon's preference. Post-operatively, patients were kept on ionotropic support as required, which were then weaned off slowly as tolerated.

During the post-operative period, patients were individually evaluated for the need of pacing if they had bradycardia, taken as heart rate (HR) <50/min or asystole causing haemodynamic instability. Duration of pacing was also monitored.

Data was collected prospectively on a predesigned proforma from the patient's file, intra-operative record and electronic database. All subjects were assigned a unique de-identification number. Demographic, clinical and peri-operative variables included age, gender, co-morbidities, like hypertension (HTN), diabetes mellitus (DM), chronic kidney disease (CKD), chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), presence of pre-operative arrhythmias, use of anti-arrhythmic medications, ejection fraction (EF) on echocardiography, history of recent myocardial infarction (MI) and presence of left main coronary artery stenosis. During their hospital stay, frequency of therapeutic use of TEPWs was recorded for the type and duration of arrhythmias. Any complications during its placement or removal, length of hospital stay (LOS) of the patients and their post-operative outcomes were also recorded.

Data was analysed using SPSS 22. Mean ± standard deviation (SD) / median along with interquartile range (IQR) were calculated for quantitative variables, such as age, weight, height, body mass index (BMI), EF (%) and LOS (days). Frequencies and percentages were calculated for gender, presence of co-morbidities, history of recent MI, pre-operative arrhythmias, post-operative arrhythmias, in-hospital mortality and pacing requirement. Independent sample t-test was used to assess difference between continuous variables of those who require TEPWs and those who did not. Chi-square test was used to assess significant difference between qualitative variables. Univariate and multivariate logistic regression analysis was performed, and crude and adjusted odds ratios (AORs) were calculated to identify independent predictors of use of TEPWs in patients undergoing isolated CABG. $P<0.05$ was considered statistically significant.

Results

Of the 322 cases evaluated, 27(8.4%) required the use of TEPWs. Mean age of the patients requiring temporary epicardial pacing wires was 66.3±8.9 years compared to 58.7±8.9 years in those who did not require it ($p<0.001$), while the left ventricular EF (LVEF) percentage was 44.1±12.8 and 48.9±12.8 respectively ($p=0.032$) (Table-1).

Table-1: Baseline characteristics (n=322).

Variable	TPW used		P value
	Yes, n=27	No, n=295	
Age in years ±SD	66.3 ± 8.9	58.7 ± 8.9	<0.001
BMI (Kg/m2) ±SD	26.7 ± 4.1	28.2 ± 4.1	0.140
Gender			
Male n(%)	22 (81.5)	246 (83.4)	0.799
Female n(%)	5 (18.5)	49 (16.6)	
Diabetes n(%)	17 (63)	182 (61.7)	0.897
Hypertension n (%)	22 (81.5)	237 (80.3)	0.886
COPD n (%)	2 (7.4)	21 (7.1)	0.956
Chronic Renal Failure n (%)	1 (3.7)	12 (4.1)	0.927
NYHA class			
II-III n (%)	24 (88.9)	258 (87.5)	0.829
IV n (%)	3 (11.1)	37 (12.5)	
LVEF % ±SD	44.1 ± 12.8	48.9 ± 12.8	0.032
Anti-arrhythmic used n (%)	2 (7.4)	19 (6.4)	0.846

BMI: Body mass index, COPD: Chronic obstructive pulmonary disease, NYHA: New York Heart Association functional classification, LVEF: Left ventricular ejection fraction.

Table-2: Peri-operative variables (n=322).

Variable	TEPW used		P value
	Yes, n=27	No, n=295	
Priority of Surgery			
- Elective n (%)	24 (88.9)	250 (84.7)	0.563
- Urgent n (%)	3 (11.1)	45 (15.3)	
IABP used in OR n (%)	3 (11.1)	17 (5.8)	0.270
Inotropes used in OR n (%)	25 (92.6)	270 (91.5)	0.848
Pacing in OR required n (%)	5 (18.5)	59 (20)	0.854
Type of Pacing wire used			
- Ventricular n (%)	1 (3.7)	51 (17.3)	0.005
- Atrial n (%)	2 (7.4)	3 (1.0)	
- AV Sequential n (%)	2 (7.4)	5 (1.7)	
Cardioplegia Type			
- Blood Cardioplegia n (%)	22 (81.5)	263 (89.2)	0.232
- Dilnido n (%)	5 (18.5)	32 (10.8)	
PPM required n (%)	3 (11.1)	0 (0.0)	<0.001
CCT (min) ±SD	72 ± 18.6	66.7 ± 18.6	0.224
Bypass time (min) ±SD	109.3 ± 26.9	104.6 ± 26.9	0.453
LOS (days) ±SD	8.0 ± 2.6	7.3 ± 2.6	0.229
In Hospital Mortality n (%)	0 (0)	9 (3.1)	0.357

IABP: Intra-aortic balloon pump, PPM: Permanent pacemaker, CCT: Aortic cross-clamp time, LOS: Length of hospital stay.
TEPW: Temporary Epicardial Pacing Wires, OR: Odds ratio, SD: Standard deviation.

Among those who required TEPW post-operatively, 5(18.5%) required pacing in the operating room while coming off cardiopulmonary bypass. The type of pacing mode used in these patients was atrial and AV sequential in 2(40%) each, and ventricular pacing in 1(20%). Besides, 3(11.11%) patients needed a permanent pacemaker due to persistent complete AV block (Table-2).

After adjusting for clinically plausible demographics and peri-operative variables, increasing age and low EF were estimated as independent predictors of post-operative TEPW (Table-3).

Table-3: Univariate and multivariate logistic regression analysis (n=322).

Variables	Crude OR (95% CI)	P value	Adjusted OR* (95% CI)	P value
Age in years	0.91 (0.87,0.96)	<0.001	0.91 (0.86,0.96)	<0.001
Male gender	1.14 (0.41,3.16)	0.800	1.04 (0.34,3.13)	0.950
BMI Kg/m^2	1.07 (0.98,1.17)	0.139	1.00 (0.91,1.09)	0.976
Diabetes	1.06 (0.47,2.39)	0.897	1.09 (0.44,2.70)	0.850
Hypertension	1.08 (0.39,2.96)	0.886	1.15 (0.38,3.53)	0.806
COPD	1.04 (0.23,4.71)	0.956	1.03 (0.20,5.35)	0.976
NYHA class IV vs. II-III	1.15 (0.33,4.00)	0.829	2.08 (0.50,8.60)	0.313
Chronic Renal Failure	1.10 (0.14,8.82)	0.927	1.03 (0.11,9.42)	0.977
LVEF% (< 30%)	1.04 (1.0,1.07)	0.035	1.05 (1.01,1.09)	0.020
No Anti arrhythmic drugs	1.16 (0.26,5.28)	0.846	1.03 (0.18,6.12)	0.970
Urgent vs. Elective surgery	1.44 (0.42,4.98)	0.565	1.52 (0.39,5.9)	0.545
Bypass time (min)	1.00 (0.98,1.01)	0.452	1.01 (0.98,1.04)	0.488
Aortic Cross clamp time (min)	0.99 (0.97,1.01)	0.225	0.97 (0.94,1.01)	0.165

*Adjusting for all covariates in the model. COPD: Chronic obstructive pulmonary disease, NYHA: New York Heart Association functional classification, LVEF: Left ventricular ejection fraction.
CI: Confidence Interval, OR: Odds ratio, BMI: Body mass index.

Discussion

The practice of placing TEPWs in isolated CABG is controversial and no consensus yet exists amongst cardiac surgeons for their routine or selective placement. To our knowledge, the current study is one of the few in developing countries, such as Pakistan, to assess the frequency of TEPW usage in the post-operative period of CABG and its predictors. The current results support the selective approach in placing TEPWs in isolated CABG, with the selective groups including patients with advanced age and low pre-operative EF.

The guidelines issued by the American College of Cardiology (ACC), the American Heart Association (AHA) and the Heart Rhythm Society (HRS) in 2018 recommended that the routine placement of TEPWs was reasonable as it has been the standard surgical practice.[15] However, over the recent years there has been a growing number of studies that have examined TEPW use and questioned their routine insertion.[2,11,16] One such study found that routine placement of TEPWs had a negligible role and was associated with increased cost and potential complications.[11] Another study found that TEPW implantation is utilised a lot more frequently than needed in cardiac surgery and that it is important to identify independent predictors so that the placement of TEPW can be limited to selected patient populations.[16] The current study also showed that TEPWs should only be placed in high-risk populations.

The patients in the current study had significant medical

co-morbidities, making this a diverse sample. The AKUH also has a good cardiac surgery turnover rate, as our one-year prospective study recruited 322 isolated CABG patients of which 85.1% were elective cases and 14.9% were urgent ones. The overall mean age of the patients was 59.3±9.1 years which coincided with data from international studies.[1]

In the current study low rate of TEPW usage (8.4%) was found comparable to a study showing a usage rate of 8.6%. Other studies conducted showed as low as 2.9% while one study reported that only 1% of patients required TEPW if predictors for its use were controlled beforehand.[11]

Interestingly, the current study found increasing age and low pre-operative EF as key independent risk factors for TEPW usage post-operatively after adjusting for multiple covariates. TEPW implantation was likely to increase by 9% with increase in every additional age year and by 5% with decrease in every EF percentage. Both these predictors are reasonable and intuitive, as increasing age is associated with increased risk of multiple co-morbidities that may increase the severity of coronary artery disease, while a low LVEF indicates heart failure and possible cardiomegaly which are all attributable risk of post-operative arrhythmias. The current study did not find any significant association between gender, DM, COPD, CKD, and previous anti-arrhythmic drug which was in line with literature.[1,2,16,17]

Since the current study was conducted prospectively, there was greater accuracy of data without any missing information. Additionally, the sample size was adequate to run a multivariate regression model to make robust conclusions. However, the findings from this single-centre research might not be generalisable over other populations. The study was also limited in terms of using non-probability consecutive sampling technique.

Conclusion

There was a low frequency of TEPWs usage post-operatively, and increased age and low EF were found to be significant predictors for its use in isolated CABG patients.

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Conflict of Interest: None.

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RESEARCH ARTICLE

Factors affecting specialty choice of postgraduate dental residents in Karachi, Pakistan

Samira Adnan, Maham Muneeb Lone

Abstract

Objective: To identify factors that influence the choice of specialty of dentistry postgraduate residents in an urban setting.

Method: The cross-sectional analytical study was conducted from April to May 2020 at health centres approved for the Fellowship of the College of Physicians and Surgeons training in Karachi, and comprised dental postgraduate residents. Data was collected using a questionnaire distributed using Google Forms. Residents were asked to rate factors that influenced their decision to join their clinical specialty on a 3-point Likert scale. Items were based on the basis of anticipated clinical experiences, specialty-specific factors, personal preferences, and possible constraints. Data was analysed using SPSS 23.

Results: Of the 51 subjects, 39(76.5%) were females and 12(23.5%) were males. The overall mean age was 27.7±2.17 years. Besides, 27(52.9%) subjects were from public-sector centres and 24(47.1%) from private-sector centres. Of all the residents, 44(86.3%) chose their specialty because of inclination to treat complex cases, while 43(84.3%) were interested because of the broad range of cases, and 39(76.5%) made their choice because of the reputation of the respective supervisors and institutions. Also, 43(84.3%) residents did not consider the expiry of their fellowship part one exam deadline, or unavailability of a training slot as a specific reason to select a specialty. Compared to males, significantly more females opted for a specialty if it eventually provided career opportunity as faculty ($p<0.05$).

Conclusion: Factors that greatly influenced the residents' choice for postgraduate training specialty were related to anticipated clinical experiences.

Keywords: Career choice, Dental specialties and sub-specialties, Postgraduate training, Influencing factors, Motivational. (JPMA 72: S-20 [Suppl. 1]; 2022)

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Introduction

Postgraduate (PG) training in various specialties of dentistry is well established globally as well as in Pakistan. A large number of dental students graduating from different institutions are interested in and actively pursuing PG degrees in basic and clinical dental sciences. Studies have shown that as a global phenomenon, dental graduates prefer to continue their education towards a PG degree.[1-3] Among the PG degrees available to dental graduates in Pakistan, the Fellowship of the College of Physicians and Surgeons (FCPS) offered by the College of Physicians and Surgeons Pakistan (CPSP) is a well-established and prestigious programme whose credentialing holds significant repute and standing in the country as well as globally. Training programmes in major clinical specialties of dentistry currently being offered by the CPSP in different training institutions across Pakistan include Operative Dentistry, Orthodontics, Oral Surgery, Prosthodontics and Periodontology.[4]

A number of factors may influence the choice of residents to join a particular PG residency programme in a specific specialty. It is essential that such factors be explored in order to evaluate the rationale behind such a decision. Such analysis is important as the career choice of students influences their future work productivity and motivation.[5] A few studies have evaluated the influencing factors determining the choice of specialty in the field of medicine for PG residents, highlighting multiple reasons based on a wide spectrum of motivational determinants, like personal preferences, lifestyle, practice considerations and specialty of their mentors.[6-9] A study[8] done on internal medicine residents reported the difference observed between genders related to these factors. Similarly, another study[7] observing the reasons behind the residents for choosing a specialty reported a difference between males and females in terms of motives for selecting a training specialty. In the local context, some research has been conducted to observe the preference of PG specialty that final year dental students would consider in the future.[10,11] However, there is scant data regarding factors influencing specialty choice of PG dental residents already enrolled in specialisation programmes. The current study was planned to identify the factors that influence the choice of specialty training of PG residents pursuing FCPS in different training institutions in an urban setting.

Subjects and Methods

The cross-sectional analytical study was conducted from April

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to May 2020 at health centres approved for the FCPS training in Karachi. After approval from the institutional ethics review board of Jinnah Sindh Medical University (Ref no. JSMU/IRB/2019/-198), data was collected using a structured questionnaire which was developed in the light of published studies[6-9] with similar methodologies, recording the factors influencing the choice of specialty of PG residents. The relevant studies were downloaded and all items of each questionnaire were reviewed. The common themes were consolidated to develop the questionnaire with items based on external and internal influencing factors, where responses could be recorded on a 3-point Likert scale. The questionnaire comprised two sections. The first section was designed to acquire consent and collect information regarding the demographics of the respondents, including age, gender, their association with public or private institution along with their level of residency and specialty. Identifiers, such as the names of the respondents and their institutions and their email addresses were optional. The second section of the questionnaire gathered data regarding factors and determinants that influenced the respondents to join their current clinical specialty for PG training. The items were based on themes, such as anticipated clinical experiences, specialty-specific factors, training centre/institution and programme-related factors, influences, post-training incentives and benefits, personal preferences and possible constraints.

All dental PG residents from first to final year of residency involved in FCPS training at institutions approved by the CPSP as FCPS training centers were approached. The institutions included the Altamash Institute of Dental Medicine, Aga Khan University Hospital, Dr Ishrat-ul-Ebad Khan Institute of Oral Health Sciences, Fatima Jinnah Dental College, Hamdard College of Medicine and Dentistry, PNS Shifa, Sindh Institute of Oral Health Science, Karachi Medical and Dental College, Alvi Dental Hospital, Liaquat College of Medicine and Dentistry, Ziauddin Dental College and the Jinnah Postgraduate Medical Centre. The PG residents who did not give consent and those who had switched their specialty during their training period for any reason were excluded.

The total number of post graduate students enrolled in residency programmes in the city are approximately 204. This estimate was obtained by official correspondence e-mail to CPSP. The sample size was calculated using OpenEpi 3.01 for epidemiological statistics.[12] As we had no specific outcome target, the sample size was calculated on the assumption that the anticipated maximum frequency of outcome factor was 50%.[13] The required sample size at 90% confidence limit came out to be 66 post graduate students.

The questionnaire was piloted by administering it by hand to approximately 10% of the total study population fulfilling the inclusion criteria. These dental residents were not included in the final sample. In the light of the feedback and observations during the pilot study, the questionnaire was modified. The finalised questionnaire was uploaded on Google Forms, and the link for the questionnaire was shared with all residents fulfilling the inclusion criteria by non-probability purposive sampling. Any form with missing data was excluded. Informed consent was taken by all the study participants as an initial part of the questionnaire.

Data was analysed using SPSS 23. Mean and standard deviations were calculated for continuous variables, while for categorical variables, frequencies and percentages were calculated. Cross-tabulation was done of factors influencing specialty choice to several covariates, like gender, specialty choice, and type of institute. $P<0.05$ was considered statistically significant.

Results

Out of the 66 forms, 51 were returned filled completely, giving a response rate of 77.3%. Out of 51, 39(76.5%) were females and 12(23.5%) were males. The overall mean age was 27.7±2.17 years. Besides, 27(52.9%) subjects were from public-sector centres and 24(47.1%) were from private-sector centres. The largest group of PG residents was associated with Operative Dentistry 33(65%) (Figure-1), and 17(33%) were in the first year of their training (Figure-2).

Of all the residents, 44(86.3%) chose their specialty because of inclination to treat complex cases, while 43(84.3%) were

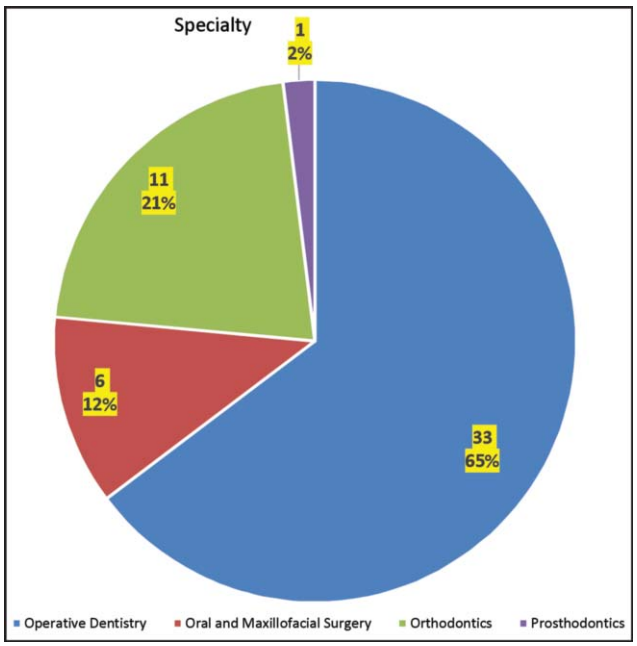

Figure-1: Distribution of Fellowship of the College of Physicians and Surgeons (FCPS) residents' specialties of training.

Table-1: Factors that motivated residents when choosing a clinical dental specialty.

Factor	Agree n (%)	Neutral n (%)	Disagree n (%)
My chosen specialty has great research opportunities	42 (82.4)	7 (13.7)	2 (3.9)
I was always interested in this specialty	39 (76.5)	8 (15.7)	4 (7.8)
I was influenced by positive experiences during BDS	37 (72.5)	4 (7.8)	10 (19.6)
I was influenced by my mentor/teacher	37 (72.5)	5 (9.8)	9 (17.6)
I wanted to work in a team	36 (70.6)	8 (15.7)	7 (13.7)
There is a lot of prestige in my chosen specialty	35 (68.8)	13 (25.5)	3 (5.9)
I wanted to have fixed working hours	35 (68.6)	9 (17.6)	7 (13.7)
I did not want work-related commitments after hours	33 (64.7)	8 (15.7)	10 (19.6)
It is easier to set up my practice independently	32 (62.7)	11 (21.6)	8 (15.7)
Training was conducted at a centre convenient for me	29 (56.9)	6 (11.8)	16 (31.4)
It will allow me more time to spend with my family	26 (51.0)	11 (21.6)	14 (27.5)
There is high income in my chosen specialty	26 (51.0)	16 (31.4)	9 (17.6)
It offers good career opportunities for a faculty position	26 (51.0)	13 (25.5)	12 (23.5)
I was impressed by structure of specialty programme	25 (49.0)	12 (23.5)	14 (27.%)
I was influenced by my family/ peers	21 (41.2)	9 (17.6)	21 (41.2)
It offers good career opportunities abroad	20 (39.2)	21 (41.2)	10 (19.6)
I didn't want too much blood in my practice	18 (35.3)	11 (21.6)	22 (43.1)
I felt there are less specialists in my chosen specialty	15 (29.4)	10 (19.6)	26 (51.0)
It offers quicker promotion chances as faculty	10 (19.6)	28 (54.9)	13 (25.5)

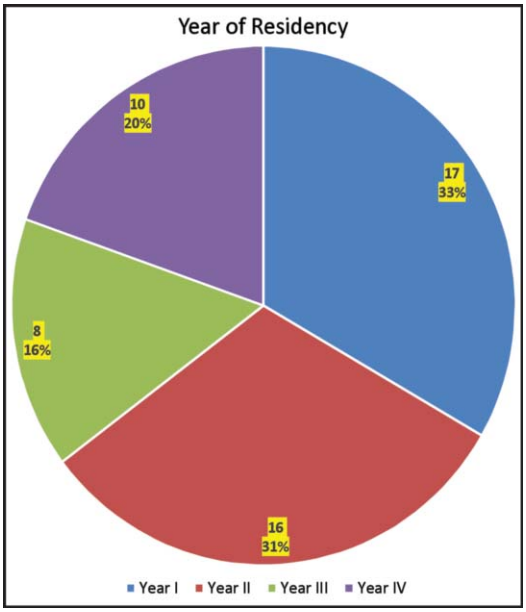

Figure-2: Level of residency of the participants.

Table-2: Factors for making the choice according to the specialty of the residents.

Clinical Specialty	Agree n (%)	Not sure n (%)	Disagree n (%)	p-value
I did not want to work emergency shifts				
Operative Dentistry	13 (39.4)	11 (33.3)	9 (27.3)	0.02*
Oral and Maxillofacial Surgery	0 (0)	0 (0)	6 (100)	
Orthodontics	3 (27.3)	5 (45.4)	3 (27.3)	
Prosthodontics	1 (100)	0 (0)	0 (0)	
I was always interested in this specialty				
Operative Dentistry	25 (75.7)	6 (18.2)	2 (6.1)	0.03*
Oral and Maxillofacial Surgery	6 (100)	0 (0)	0 (0)	
Orthodontics	8 (72.7)	2 (18.2)	1 (9.1)	
Prosthodontics	0 (0)	0 (0)	1 (100)	
I wanted the opportunity to treat complex conditions/cases				
Operative Dentistry	28 (84.8)	3 (9.1)	2 (6.1)	0.007*
Oral and Maxillofacial Surgery	6 (100)	0 (0)	0 (0)	
Orthodontics	10 (90.9)	1 (9.1)	0 (0)	
Prosthodontics	0 (0)	0 (0)	1 (100%)	
I wanted to encounter a broad range of conditions to treat				
Operative Dentistry	27 (81.2)	3 (9.1)	3 (9.1)	0.03*
Oral and Maxillofacial Surgery	6 (100)	0 (0)	0 (0)	
Orthodontics	10 (90.9)	1 (9.1)	0 (0)	
Prosthodontics	0 (0)	0 (0)	1 (100)	

* p <0.05 was taken as statistically significant. n: number of postgraduate residents.

interested because of the broad range of cases, and 39(76.5%) made their choice because of the reputation of the respective supervisors and institutions. Also, 43(84.3%) residents did not consider the expiry of their fellowship part one exam deadline, or unavailability of a training slot as a specific reason to select a specialty (Table-1).

There was significant difference in a few of the motivational factors among the residents of different clinical specialties (Table-2). Compared to males 2(16.7%), significantly more females 24(61.5%) opted for a specialty if it eventually provided career opportunity as faculty (p<0.05).

Discussion

The current study is the first in the local context that assessed the factors that PG residents considered when choosing a clinical dental specialty. Studies have been conducted on dental graduates in other parts of the world identifying factors behind specialty choice.[10,11,14-16] Research has also been conducted locally in dental colleges and among graduates of Karachi to assess the motivational factors of undergraduate students to opt for dentistry as a career.[17,18] In Pakistan, there are around 29,000 registered dental practitioners. The country has an estimated total population of 220 million, thus there is a dentist-to-population ratio of 1:7500. Specialist clinical dental practitioners are far less; an estimated number is only 10% of the total registered dentists i.e. 2900. This is because there are minimal PG options with limited seats available nationwide.[19] Thus, it is imperative that the motivational factors behind the choice of a specialty are considered before the residents are inducted so that they do not suffer from professional discontent during or at the completion of their residency training or may have to switch specialty midway if opportunity arises. Such practices would lead to inefficient

training programmes and practices, with erosion of the required number of dental specialists for serving the community.

There was significantly higher number of female participants in the current study. This finding is similar to studies done in Turkish and Thai dental schools.[14,21] A plausible explanation could be the overall greater number of female students pursuing dentistry in Karachi.[17] All specialties had more respondents that were female. A statistically significant difference was only recorded where a larger percentage of females (61.5%) compared to males (16.7%) agreed that they chose the PG specialty if there were chances that it may provide a better career opportunity as faculty in subsequent years. Other than that, all participants had similar motivational factors to pursue specialty of their choice irrespective of gender in the current study.

A positive trend was seen to the effect that PG residents were looking forward to clinical experiences specific to the specialty chosen by them, indicating that the learning offered by a particular specialty seems to be the primary reason for the choice. This would ensure continued, motivated engagement and deeper learning of the trainees as they progress in their training. Satisfaction in providing care in specialty of choice was one of the most agreed upon reason in a study done among residents in the United States.[21]

The study participants expressed a deep interest in research opportunities that their chosen specialty provided. Research was quoted as being an essential factor motivating the trainees to join their preferred specialty. This is a positive inclination, indicating that the trainees are aware of the importance of research and are motivated in joining a specialty where research avenues can be pursued. Even though FCPS is primarily a clinical degree, there should be an emphasis on the component of research since such measures promote evidence-based clinical practices.[22,23]

Related to the training institution and the structure of training programme, the motivating factor was the reputation of the training institution itself and of the training supervisor because supervisors who takes special interest in guiding and enhancing the learning and skills of the residents are the most sought after.[23] Prestige of the specialty was also a significant factor for specialty choice for a large number of residents. This is similar to earlier findings.[10,14,15]

The positive influences of mentors were an important motivating factors in the current study which was in line with literature16. Such positive practices need to be promoted at the undergraduate level as well.[17,18,20,25] The influence of family members and spouses was not seen to have a significant impact towards specialty choice in the current study, which was in contrast to earlier reports.[26] This highlights the importance of conducting similar studies in different demographical settings as influencing factors for specialty choice may vary greatly.[26,27]

Responses related to career and financial opportunities perceived after the completion of PG training depicted the prospect of setting independent private practice as the most significant factor in specialty choice. This was followed by the chance of becoming a supervisor to train other residents in the same specialty. The financial returns and possible faculty position were the other considerations. The interest of the current trainees in becoming supervisors later in their career depicts the desire to transfer their knowledge and skill to future trainees. This is a positive tendency as this would help to perpetuate the specialty practices in dentistry.[14,28]

The personal interest of the trainees in the specialty they joined also ranked significantly high among the responses. Similar findings were observed in other studies.[11,13] Other noteworthy factors were related to the interest in working as part of a team and those mentioning the time duration of training-related activities.[15] Trainees also considered the after-work commitments and work-life balance as essential factors for specialty choice. An important consideration leading to this trend could be that the majority of the participants were female, and had multiple commitments related to family. However, despite this gender determinant, a study assessing the factors influencing medical students' choice of specialisation globally reported lifestyle and work-life balance as the top most governing elements, followed by interest in discipline.[2,29]

Contrary to the popular belief in Pakistan that since slots for FCPS training in dentistry are limited, potential trainees often opt for a specialty programme which is not their primary interest, the current study had a large number of participants who reported otherwise. Similarly, the impeding expiration date of of FCPS part one exam[17] was also not reported as an influencing factor for specialty choice for most residents. This is an encouraging outcome, since these factors should not determine a trainee's selection of a field for specialty training. If this were the case, the lack of motivation and interest could result in poor performance during training and would subsequently affect clinical practice and patient care.[30]

In terms of limitations, the current study comprised residents undergoing FCPS training in Karachi only, and, therefore, the results cannot be generalised. In addition, only trainees of FCPS programme were included, while the residents of other PG programmes were left out. The sample size was also small, and the majority of responses came from residents training in Operative Dentistry.

Conclusion

Factors that greatly influenced the residents' choice for postgraduate training specialty were related to anticipated clinical experiences. Factors which the residents reported to have minimal influence on their decision-making included the potential lack of training slots in the specialty of primary interest as well as the impending expiry of the validity of their FCPS part one examination.

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Conflict of Interest: None.

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RESEARCH ARTICLE

Diagnostic accuracy of axillary nodal ultrasound after neoadjuvant chemotherapy in node-positive breast cancer patients: A validation study

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Abstract

Objective: To determine the accuracy and false negative rate of axillary ultrasound compared to sentinel node biopsy.

Method: The retrospective study was conducted at the Aga Khan University Hospital, Karachi, from February 1 to March 31, 2021, and comprised data of breast cancer patients who had undergone neo-adjuvant chemotherapy followed by axillary lymph node dissection or axillary disease diagnosed using lymph node biopsy or sentinel lymph node biopsy between January 1, 2016, and December 30, 2020. After receiving neoadjuvant chemotherapy, axillary ultrasound findings were compared with histopathology of lymph nodes. Data was analysed using SPSS 22.

Results: Of the 155 patients evaluated, 104(67.1%) were diagnosed with negative axillary lymph nodes and 51(32.9%) were diagnosed with positive axillary lymph nodes post-chemotherapy. The overall mean age was 51.13±1.3 years. When histopathology results were compared with those of axillary ultrasound, 36(23.2%) cases turned out to be true positive, while 23(14,8%) were false negative, yielding a positive predictive value of 75% and negative predictive value of 65%. Axillary ultrasound had 75% accuracy, false negative rate 30%, sensitivity 61% and specificity 84.4%.

Conclusion: Axillary ultrasound was found to be fairly useful, but not completely reliable, in identifying positive lymph nodes, .

Keywords: Neoadjuvant chemotherapy, Ultrasound axilla, Sensitivity, False negative rate.

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Introduction

For the past few decades, axillary nodal status has been the cornerstone in breast cancer staging, making axillary surgery part and parcel of breast cancer surgery.[1] Axillary lymph node dissection (ALND), however, comes with significant morbidity of swelling in the arms, numbness and restricted arm movements in up to 40% patients.[2] With increasing knowledge of tumour biology as a more important diagnostic factor and milestones achieved in the de-escalation of breast surgery to reduce morbidity, the need for ALND was questioned. This led to the concept of sentinel lymph node biopsy (SLNB) which now represents routine care in node-negative, early breast cancer patients.[3] Although neo-adjuvant chemotherapy (NACT) allowed breast conservation surgeries to be offered to patients who presented with advance disease, standard ALND remained in practice in post-neo-adjuvant settings. This was mostly because of concern that altered lymphatic drainage pertaining to post-systemic treatment fibrosis may lead to inaccurate SLNB results.[4] Nevertheless, enthusiasm to tailor breast and axillary surgery grew with the knowledge that a number of individuals who receive NACT achieve a pathologically complete response (pCR), defined as no residual infiltrating disease in the breast and the axillary lymph nodes. The rate of achieving pCR strongly correlated with subtypes of breast cancer.[5]

Two large multi-centre prospective clinical trials subsequently validated the feasibility of SLNB in individuals who had positive axillary nodal disease at presentation and achieved a clinically node-negative status after receiving NACT. Both the studies reported a false negative rate (FNR) of 12.6% to 14.2% for SLNB which was above the accepted threshold of 10%.[6-8] The FNR was optimised to <10% using dual tracer, removing three sentinel nodes and clipping biopsied nodes.[9]

Currently available imaging modalities for pre-operative evaluation of axilla in breast cancer patients include mammogram (MMG), axillary ultrasound (aUS), computed tomography (CT) and magnetic resonance imaging (MRI). MMG has diagnostic accuracy of 79.5%, but is unreliable as part of axilla may not be visualised on routine MMG. CT scan and MRI are not usually used for general evaluation of axilla as they are expensive, but are helpful when the extent of disease needs to be evaluated.[10] Thus, aUS is the imaging of choice for initial axillary assessment of patients, but there is significant difference of reported sensitivity (27-94%) and specificity (53-100%).[11] Despite

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being operator-dependent, it has outperformed other imaging techniques with the advantage of being less expensive and non-invasive, thereby becoming routine practice.[12] In an attempt to decrease FNR, studies have explored the use of US to identify nodes for SLNB and reported an FNR decrease to 9.8% when used with dual tracer techniques.[13] Sensitivity 71% and specificity 88% was reported using aUS with 83% negative predictive value (NPV) and 29% FNR.[14]

Formal re-staging of axilla post-NACT was adopted at the study site in 2015. The current study was planned to determine the accuracy and FNR of aUS compared to SLNB since the change.

Materials and Methods

The retrospective study was conducted at the Aga Khan University Hospital (AKUH), Karachi, from February 1 to March 31, 2021, and comprised data of breast cancer patients who had undergone NACT followed by ALND or SLNB between January 1, 2016, and December 30, 2020. After exemption from the institutional ethics review committee, hospital database was used to identify patients and data was collected on a self-designed questionnaire. Ultrasound axilla reports of patients who received primary NACT were matched with histopathology reports of axillary nodes after definitive surgery which is the gold standard, categorised as positive for lymph nodes with residual tumour, and negative on the absence of such findings. Data was also obtained on age, grade and biology of tumour, stage of breast cancer, and the chemotherapy regimen used. The sensitivity and specificity of aUS was identified through receiver operating characteristic (ROC) curve. Data was analysed using SPSS 22. Descriptive data was reported for quantitative and qualitative variables as mean and standard deviation, median and interquartile range (IQR), and frequencies and percentages, as appropriate. Chi-square test was used to test positive predictive value (PPV) and negative predictive value (NPV) of aUS in relation to post-ALND and immunohistochemistry. ROC curve was used to test the specificity and sensitivity of aUS. $P<0.05$ was considered statistically significant.

Results

Of the 155 patients evaluated, 104(67.1%) were diagnosed with negative axillary lymph nodes and 51(32.9%) were diagnosed with positive axillary lymph nodes post-chemotherapy. The overall mean age was 51.13±1.3 years. The median time for follow-up from the start of NACT to surgery was 6 months (IQR: 3-9 months). Demographic and baseline clinical data was noted (Table-1).

Table-1: Baseline characteristics of tumour and patient demographics.

Characterstics	No. (%)
Age (mean), years	51.13±1.13
Menopausal status	
Premenopausal	63 (40.6%)
Perimenopausal	71 (45.8%)
Postmenopausal	21 (13.5%)
Receptor Status	
ER-/PR-/Her2-	64 (41.5%)
ER/PR+/HEr2+	30 (19.5%)
ER/PR+/Her2-	45 (29.2%)
ER/PR-/HER2+	15 (9.7%)
Size of Invasive focus	
Complete Response	43 (27.7%)
<1 cm	41 (26.4%)
1-2 cm	35 (22.6%)
>2 cm	36 (23.2%)
Grade of cancer	
Grade I	1 (0.6%)
Grade II	90 (58%)
Grade III	64 (41.2%)
Clinical Stage	
T1N0	7 (4.5%)
T1N1	14 (9%)
T2N0	21 (13.5%)
T2N1	83 (53.5%)
T3N0	4 (2.5%)
T3N1	18 (11.6%)
T4N0	2 (1.3%)
T4N1	6 (3.8%)
Histopathology Findings	
IDC	5 (3.2%)
Others	150 (96.8%)
Lymph nodes status post NACT	
Negative axillary lymph nodes post NACT	101 (67.1%)
Positive axillary lymph nodes post NACT	54 (32.9%)
Total No Of Sentinel Nodes Retrieved	
No Sentinel lymph node retrieved	33 (42.2%)
1	5 (0.1%)
2	16 (0.6%)
3	33 (25.5%)
>3	22 (24.4%)
Axillary lymph nodes positive on histopathology after SLN Biopsy	
None	44 (75.9%)
1	11 (19%)
2	2 (3.4%)
3 or >3	1 (1.7%)
Axillary lymph node dissection given	112 (72.2%)
Nodes recovered in ALND	
None	3 (2.2%)
<3	1 (0.7%)
<10	7 (5.1%)
<20	63 (45.7%)
<30	34 (24.6%)
<40	5 (3.6%)
No. of positive lymph nodes after ALND	
None	55 (48.2%)
<3	30 (26.3%)
<5	8 (7.1%)
<10	15 (13.1%)
<20	6 (5.3%)

SD: Standard deviation, ER: Oestrogen receptor, PR: Progesterone receptor, HER2: Human epidermal growth factor receptor 2, SLN: Sentinel lymph node, IDC: Invasive ductal carcinoma, NACT: Neo-adjuvant chemotherapy, ALND: Axillary lymph node dissection.

Table-2: Diagnostic characteristics of ultrasound (US) modality.

	Axillary US post NACT Residual Disease	Axillary US post NACT No Residual Disease	
Residual Disease on Histopathology	True Positive n=31	False Negative n=36	Sensitivity=61%
No Residual Disease on Histopathology	False Positive n=20	True Negative n=68	Specificity=84.4%
Accuracy= 75%	Positive Predictive Value = 75%	Negative Predictive Value = 65%	False Negative Rate =30%

NACT: Neo-adjuvant chemotherapy.

Table-3: Diagnostic PPV and NPV according to tumour phenotype.

Tumour histopathological subtype	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)
ER+ HER2-	100%	50%
ER+ HER2+	64%	57%
ER- HER2+	82%	71%
ER- HER2-	60%	75%

ER: Oestrogen receptor, HER2: Human epidermal growth factor receptor 2.

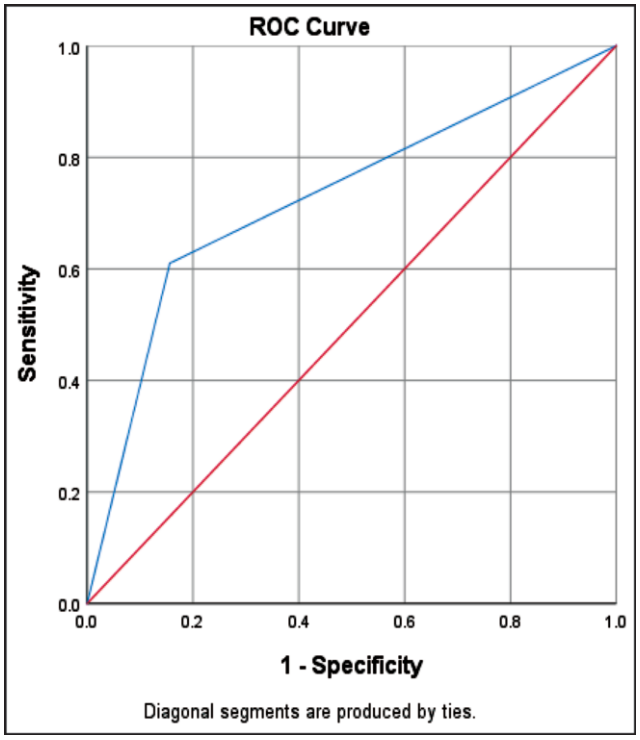
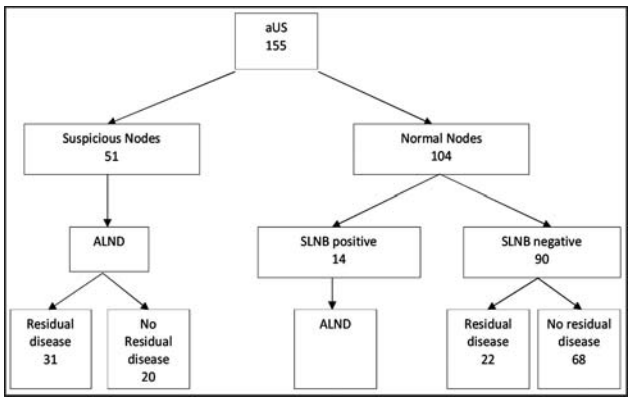


Figure-1: ROC: Receiver operating characteristic (ROC) curve illustrating the sensitivity and specificity of axillary ultrasound (aUS). Area under curve (AUC) = 0.73.

When histopathology results were compared with those of aUS, 36 cases turned out to be true positive (TP), while 23(%) were false negative (FN), yielding a PPV of 75% and NPV of 65%. The aUS had 75% accuracy, FNR 30%, sensitivity 61% and specificity 84.4% (Table-2).

ROC curve showed 61% aUS sensitivity and 84% aUS specificity (Figure-1). The area under curve (AUC) was 0.73



aUS: Axillary ultrasound, SLNB: Sentinel lymph node biopsy, ALND: Axillary lymph node dissection. SLNB is showing false negative rate (FNR) of 12.5% while aUS is showing FNR of 30%.

Figure-2: Boughey's algorithm.

(Standard error=0.04; p=0.001).

Diagnostic PPV and NPV according to tumour phenotype were noted separately (Table-3). SLNB had a FNR 12.5% compared to aUS FNR 30% (Figure-2).

Discussion

The aUS is a vital adjunct to breast imaging in the staging of breast cancers. The lymph nodal status not only guides the treatment, but also provides valuable prognostic information. The major lymphatic drainage from the breast is to the ipsilateral axillary nodes which are best assessed by US. They may be categorised as suspicious (thickened cortex, loss of fatty hilum) or normal (having an intact hilum, cortex <3mm). Concordance in US findings and histopathology may help avoid axillary surgery and its associated morbidity in certain patients.

In the current study, aUS FNR in post-NACT patients was 30%. FNR as low as 2% with targeted axillary dissection has been reported in studies.[15] Targeted axillary dissection, however, involves additional cost and procedures, like clip placement at the time of biopsy. Historically, FNR <10% has been considered significant to use the proposed method of nodal identification. FNR 9.8% can be achieved with a combination of aUS and

SLNB post-chemotherapy.[12]

The current study showed 61% sensitivity of aUS in diagnosing axillary metastasis post-NACT. Other studies have shown sensitivities ranging from 50% to 66% in different settings.[13,16,17] The specificity in the current study was 84%, which was comparable with other studies ranging from 37% to 92%.[18]

Studies[20,21] suggested that different subtypes of breast cancer affect the diagnostic aUS accuracy, and this should be kept in mind before making decisions. The studies reported an overall sensitivity of 60%,[19,20] which is in concordance with the current study. The specificity was 65%, which is lower than the current finding. The overall PPV and NPV were 82% and 38.5% compared to 75% and 65% in the current study. Higher PPV means that if there are suspicious US findings, there is high probability of the node being involved with cancer and the patient can proceed with an axillary dissection and prevent an unnecessary SLNB.

The studies[19,20] pointed towards non-luminal subtypes having a higher sensitivity compared to luminal subtypes, while the specificity was the same for both. The sensitivity was highest in triple-negative cancers. Similarly, the PPV was highest for luminal A subtype and the NPV was the highest for triple-negative cancer.[19,20] The current subset analysis of tumour phenotype showed similar results (Table-3). A study also presented the same results with almost 100% PPV for luminal A subtype.[21]

A newer approach to avoid unnecessary axillary dissection is called the Systemic Sonographic Axillary Staging. Any suspicious nodes after completion of NACT undergoes repeat needle biopsy, and axillary surgery is planned according to the status of biopsy results.[22]

The current study has limitations of having single-centre, retrospective data. Besides, the role of repeat biopsy of suspicious axillary nodes and effects of tumour phenotype on re-staging of axillary disease need further exploration.

Conclusion

The aUS was found to be a fairly useful, but not completely reliable, tool for identifying positive lymph nodes. Further intervention is necessary for diagnosis. Thus, histopathology remains the gold standard to identify axillary metastasis.

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RESEARCH ARTICLE

Navigating through our history in research: An altmetric analysis for publications by the full-time operative dentistry faculty at the Aga Khan University Hospital in the past decade

Nighat Naved, Fahad Umer

Abstract

Objective: To analyse the social dissemination of publications by fulltime faculty at a tertiary care facility.

Methods: The retrospective study was conducted at the Aga Khan University Hospital, Karachi, and comprised publication records of the fulltime Operative Dentistry faculty members between July 2011 till July 2021. The search was done on Google Scholar, Altmetric Explorer and PubMed electronic databases. After final screening, all the publications in PubMed-indexed journals, including in vitro studies, randomised controlled trials, original research articles, case reports and letters to the editor, for which the Altmetric Attention Score was available were included.

Results: Of the 225 publications identified, 34 (15%) formed the final sample. The cumulative citation count for the publications was 617 and Altmetric Attention Score was 158. There were 16 Facebook mentions and 163 tweets.

Conclusion: The social impact of publications by the Operative Dentistry faculty over a decade was not convincing in terms of Altmetric Attention Score.

Keywords: Traditional bibliometrics, Altmetrics, Altmetric Attention Score, AAS, Online attention, Social dissemination. (JPMA 72: S-30 [Suppl. 1]; 2022)

DOI: https://doi.org/10.47391/JPMA.AKU-07

Introduction

The Operative Dentistry residency programme in Pakistan dates back to 1995. However, at Aga Khan University Hospital (AKUH), the clinical training in this specialty of dentistry started in 2002, which with time has evolved into one of the finest training programmes in Pakistan. This is because in the past decade some fundamental changes were incorporated and a research curriculum was introduced to instill research skills in the residents at an early stage in their academic careers.[1] Since the trends in research are evolving, much greater emphasis is now being placed on practising evidence-based dentistry.

Nevertheless, with the emerging trends, research profile of the faculty is also improving as the number of local and international publications is increasing. This surge in the number of publications in the past decade, however, is accompanied by a dramatic improvement in the citation metrics as well.[1,2]

Citation count (CC) and its derivatives, such as impact factor (IF), H-index, and i10 index, are the traditional methods to evaluate the scientific performance of a publication.[3] However, it has certain shortcomings. Firstly, it provides insight only on the scientific value of a publication, and, thus, fails to describe the impact of research beyond the limits of an academic environment. Secondly, it may take years for a publication to be cited, thus the impact of recently published papers is generally underestimated.[4] Moreover, the "Matthew effect" can exist in the case of a citation. This effect is thought to be influenced by prestige of the author and his/her institutional affiliation.[5] Likewise, the disparity in citations may extend to include gender bias, location of publication, and the personal preference of citing an article published in a journal with a comparatively high IF.[5]

The rising influence of social media over the past decade has led to a paradigm shift as various platforms have been made available for researchers to share their scholarly ideas.[3] In this regard, the term alternative metrics, or altmetrics, was introduced in 2010 by Jason Priem.[3] These metrics in the real sense measure how much and what kind of online attention an item is receiving at any point in time, thus complementing traditional citation-based metrics.[3]

To capture the online activity around a published item, multiple aggregators are available, the most popular among which are Altmetric Explorer and Plum Analytics.[6] Likewise, different publishers use different resources for reporting these metrics.[6] Likewise, different publishers use different resources for reporting these metrics, for example, John Wiley & Sons and Springer Nature use Altmetric Explorer whereas Elsevier Publishing uses Plum

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Analytics. Among local journals, the Journal of Pakistan Medical Association subscribes to both of these tools.

Altmetric Explorer is a fee-based subscription tool that aggregates information from different social media sources, like Twitter, Facebook, etc., traditional media, like the New York Times, The Guardian, etc., and online reference managers, like Mendeley, etc. It calculates an Altmetric Attention Score (AAS) using a specific algorithm, thereby generating a colour-coded badge, with each colour representing a different source.[6] The higher the online attention an article gets, the greater is the score. Likewise, Plum Analytics, also a fee-based tool, captures the online activities providing five categories of metrics namely: Usage, Captures, Mentions, Social media, and Citations.[4]

Almetrics hold a promising future considering the many potential advantages that it offers. The attention scores are updated daily, making it possible for recently published items to gain early recognition. In addition, they cover a broader spectrum of academic as well as non-academic audiences.[3] Moreover, a significant understanding is provided about how a publication is being used in terms of a recommendation, discussion, as well as citation, etc.[3]

Nevertheless, with the emerging influence of altmetrics in today's world, the research work in this area of interest is still lacking in Pakistani setting. To address the paucity, current study was planned to explore the social dissemination of publications by full-time faculty members.

Materials and Methods

The retrospective chart review was conducted at the AKUH, Karachi, and comprised publication records of the fulltime Operative Dentistry faculty members between July 2011 till July 2021. The search was done on Google Scholar, Altmetric Explorer and PubMed electronic databases.

With the consent of three fulltime faculty members, identified as MFRK, ROBG and FUMR, their publication data across the study years was collected from the databases. All search work was done by a single investigator in August 2021. Initially, the faculty's Google Scholar profile was searched, and the records were corroborated by the individual faculty to check for any incongruity. Later, to screen the records, Altmetric Explorer was searched using article titles and Digital Object Identifiers (DOIs) to have the Altmetric Attention Score (AAS). The records for which the Altmetric database did not yield any result were excluded. After final screening, the publications in PubMed-indexed journals, including all in vitro studies, randomised controlled trials (RCTs), original research articles, case reports and letters to the editor were included.

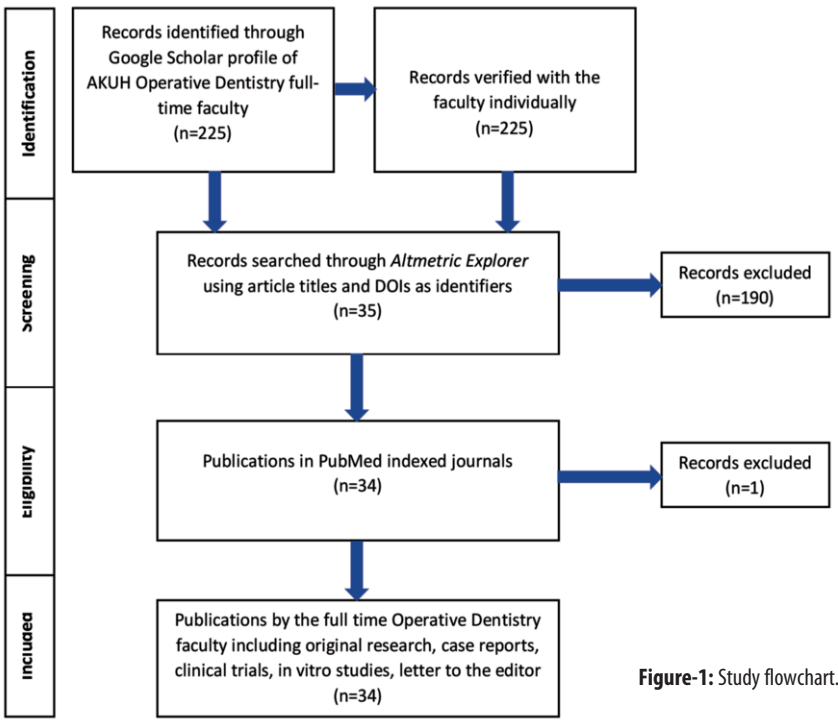


Figure-1: Study flowchart.

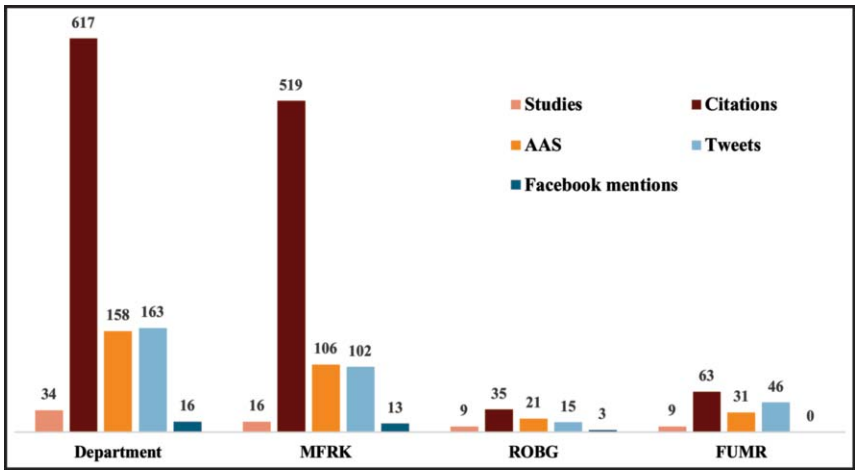


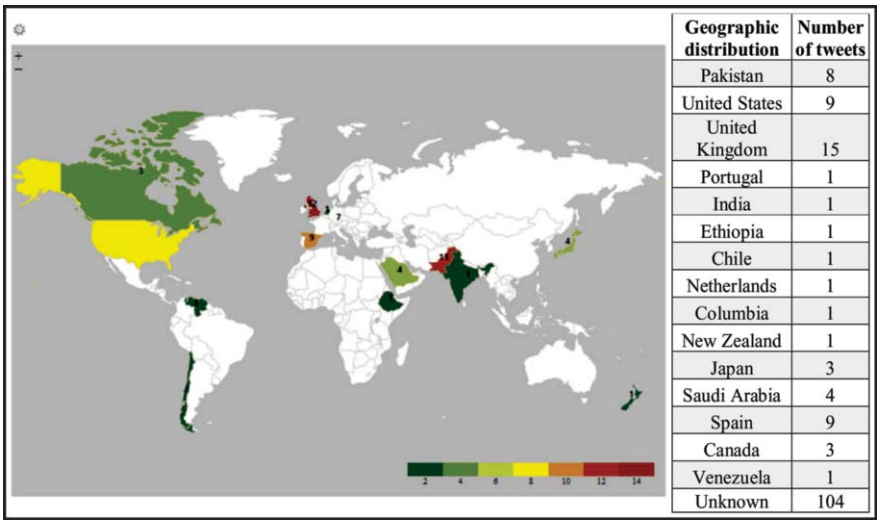
Figure-2: Faculty-wise breakdown of citation counts, Altmetric Attention Score (AAS), tweets and Facebook mentions.

Results

Of the 225 publications identified, 34(15%) formed the final sample (Figure-1). The cumulative citation count for the publications was 617 and AAS was 158. There were 16 Facebook mentions and 163 tweets. Among the three faculty members, MFRK had the greatest share in terms of the number of studies, citations and AAS (Figure-2).

In terms of geographic distribution, 104 (63.8%) of the tweets were of unknown origin, followed by 15 (9.2%) and 9 (5.52%) and 8 (4.9%) belonging to the United Kingdom, the United States and Pakistan, respectively (Figure-3).

As for demographic distribution, the tweets were most popular among the members of the general public 116(71.16%) followed by healthcare professionals 24 (14.72%) (Figure-4).



Geographic distribution	Number of tweets
Pakistan	8
United States	9
United Kingdom	15
Portugal	1
India	1
Ethiopia	1
Chile	1
Netherlands	1
Columbia	1
New Zealand	1
Japan	3
Saudi Arabia	4
Spain	9
Canada	3
Venezuela	1
Unknown	104

Figure-3: Geographic distribution of tweets.
Red colour denotes the highest value and green, the lowest value. The remaining values are assigned different gradients of the colour at the two extremes.

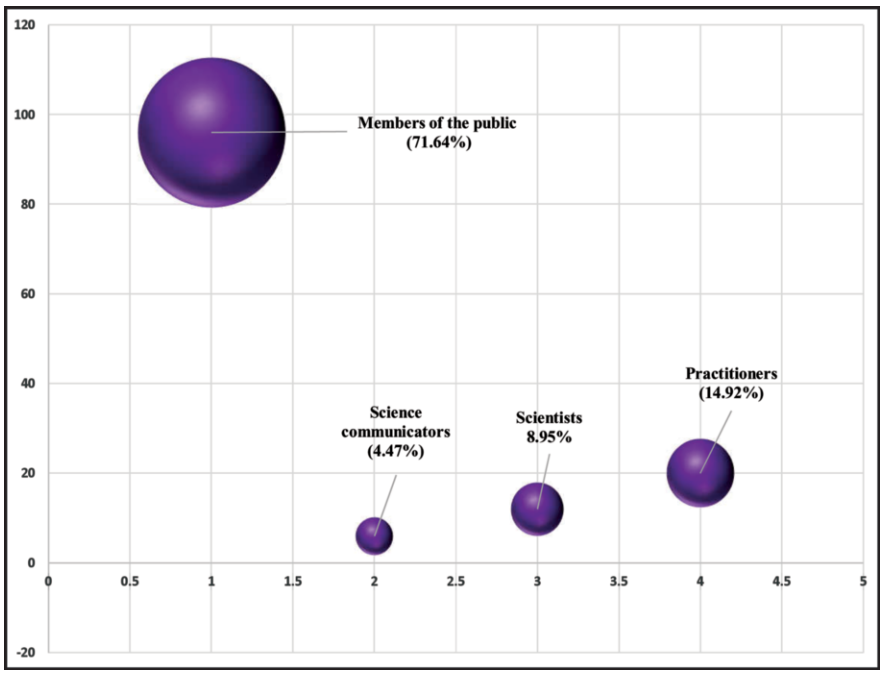


Figure-4: Demographic distribution of tweets.
Bubble sizes correspond to the number of Twitter mentions.

Discussion

The current study was planned to provide useful insight on the social impact of publications over the past decade.

Altmetrics came into existence in 2010 as an advanced metric to measure the social dissemination of a certain publication. In this context, the publications for which AAS was available on Altmetric Explorer for the study years were included. However, it was noted that most of the records were from 2016 onwards whereas only a single publication from 2013 was included in the study. This could be due to two reasons, either the Altmetric database was not able to retrieve the online attention data for the publications before 2016 or there was no social engagement of the publications before this time.

The results revealed that the major proportion of publications was captured by a single faculty member, MFRK, with 16 studies followed by the other two faculty members, ROBG and FUMR, with 9 studies each. Likewise, the CC, AAS, tweets and Facebook mentions were also significantly higher for MFRK. Moreover, it was found that among the other two faculty members with same number of publications, FUMR had greater CC, AAS and the number of tweets. In contrast, Facebook mentions for ROBG were higher whereas FUMR had virtually no online attention in terms of Facebook mentions. This disparity in social impact could be due to the individual faculty's preference for a

certain social media platform over another.[6]

The results were in line with a study which reported no significant correlation between CC and AAS.[6] For instance, of all the included studies, the top-cited publication had CC of 279, but the AAS for the same study was just 1.[8] Likewise, the study with the highest online attention had an AAS of 54 whereas CC for the same study was 91.[9]

The cumulative AAS for the publications in the current study was 158, wherein the greatest contribution was made by MFRK with an AAS of 106. Surprisingly, the major chunk to this score was contributed by a single study with AAS of 54.[9] This enhanced social engagement could be attributed to the presence of non-dental faculty members as co-authors, mentions, and re-tweets by different medical and dental organisations and journals as well as self-tweets.[7]

The pivotal finding of the current review is that coronavirus diseases-2019 (COVID-19) was among the hot topics, receiving the most online attention as well as citations. Another finding of significance is that among the 7 studies that were related to the pandemic, 6 were published by a single author, FUMR.[10-15]

According to the current study, Twitter was the most popular social media platform, followed by Facebook, which is in concordance with previous literature.[6,7] It is, however, perturbing to note that majority of the tweets were of unknown origin, making it difficult to infer the actual geographical spread of the included publications. Nevertheless, tweets had a diverse audience in almost all continents excluding Antarctica. The popularity was more in Europe (15.95%), followed by Asia (9.81%) and North America (7.36%). Although previous studies did report the actual geographical spread of tweets, they failed to communicate any demographic spread of the included publications.[6,7] In contrast, the current study revealed that tweets were found to be more trending among the members of the general public (71.64%), followed by an almost even distribution among dental and medical practitioners, scientists and science communicators.

Although altmetrics measure the real-time social impact of the publications, it has certain infirmities. It is a dynamic process that is expected to fluctuate over time. This contrasts with the traditional citation-based metrics and could be attributed either to the inactivation of an individual's social media account or the possibility of tweets or Facebook posts being deleted by the account holder. Likewise, there are concerns regarding self-tweets as is the case with self-citations. Moreover, in case of tweets, although the demographic data is available on the Explorer, the information could still be misleading because it imports the data directly from the individual's profile and we do not know whether the members of the general public actually represent the said population. The same is the case with geographical data, as observed in the study, most of the tweets were from unknown geographical locations.

In terms of limitations, the current study had access to only a single database, the Altmetric Explorer. The results may have been different if we had access to other databases, like Plum Analytics. This is because certain journals subscribe to Altmetric Explorer whereas others register with Plum Analytics. Moreover, from all the publications by the faculty in the past decade, only a small proportion (15%) was included in the present analysis, thus making it difficult to infer the actual social impact of the publications. Furthermore, although the current study was able to conclude that Twitter was the most popular platform, it failed to differentiate among positive, negative and neutral tweets which otherwise would have eliminated the probability of self-tweets.

Despite the limitations, however, the current study is the first of its kind done in our part of the world. We plan to extend the current institution-based study to a multi-centre project having access to Plum Analytics database as well for a more accurate representation of the subject matter.

With the evolving trends in technology, a plethora of social media platforms addressing a diverse audience have been made available for researchers to communicate with a global network. Thus, a shift in focus is recommended for the researchers to pay similar attention to these alternative measures of impact as the traditional citation-based metrics. Furthermore, despite all the limitations, altmetrics should be given due attention when devising promotion and hiring strategies as is the case with CCs.

Conclusion

The publications by the Operative Dentistry fulltime faculty during the past decade had a modest social impact in the community in terms of AAS. Nevertheless, the publications had a diverse geographical as well as demographical spread, demonstrating wider outreach to the non-scientific community. This allows the dissemination of important research findings, thereby promoting the institution and the practitioner amongst those seeking dental care.

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RESEARCH ARTICLE

Radiographic evaluation of the margins of clinically acceptable metal-ceramic crowns

Sheikh Bilal Badar, Kamil Zafar, Robia Ghafoor, Farhan Raza Khan

Abstract

Objective: To radiographically evaluate the proximal marginal fit of the clinically acceptable metal-ceramic crowns.

Method: The prospective study was conducted at the dental clinics of Aga Khan University, Karachi, from July to December 2018, and comprised metal-ceramic crowns that were evaluated prior to the cementation. Clinical examinations were conducted by seating the crown on the tooth preparation and visual assessment was done using sharp explorer along the margins. Clinically acceptable crowns were then evaluated on the bite-wing radiograph. Any horizontal or vertical inaccuracy of >0.5mm at the proximal margins was recorded as 'discrepancy'. Data was analysed using SPSS 22.

Results: Of the 230 interproximal margins of 115 crowns evaluated, 113(49.1%) sites had marginal discrepancies; 44(19.1%) horizontal discrepancies, 58(25.2%) vertical discrepancies, and 11(4.8%) having both horizontal and vertical discrepancies. Horizontal crown margin discrepancies were most associated with the mesial site of the maxillary crowns, while vertical discrepancies were commonly associated with the distal aspect of all crowns ($p<0.050$).

Conclusions: Almost half of the crowns that were considered clinically acceptable had some vertical or horizontal marginal discrepancy on radiographic evaluation.

Keywords: Crown, Margins, Dental radiography, Metal ceramic crowns. (JPMA 72: S-35 [Suppl. 1]; 2022)

DOI:https://doi.org/10.47391/JPMA.AKU-08

Introduction

Prosthetic crowns are indirect restorations that are placed to repair teeth, maintain occlusion and improve the aesthetics.[1,2] Endodontically treated teeth are commonly subjected to crown placement to prevent any future fracture. The margins of a crown mark the transition between the crown material and the finishing line at the recipient tooth surface. The integrity of the margins is critical for the long-term health and survival of the crowned teeth.[3,4] Crown margins should be blended and confluent with the tooth structure without having any positive or negative ledges or gaps.[5] In clinical practice, it is not uncommon to encounter crowns with faulty and imprecise margins.

Marginal discrepancies in the crown are mostly observed in scenarios where tooth preparation margins are irregular or missing. Defects in impression-taking, and pouring or laboratory errors, such as distortion in the pattern or casting shrinkage, are responsible for incorrect positioning of the crown margins.[6] Regardless of the cause, the marginal discrepancy, if left unnoticed at the trial and cementation stages, may lead to poor survival of the fixed prosthesis. The gap between the prosthesis margin and tooth-preparation margins exposes the luting cement to the oral environment, leading to an increased rate of cement dissolution. This could ultimately lead to percolation of bacteria, resulting in compromised longevity of the tooth due to caries.[7] Studies have also shown the association between margin discrepancies and the presence of caries in adjacent teeth.[8-10] Before cementing any crown, the try-in step offers an opportunity to the clinician to ensure that the margins of the fixed prosthesis, especially at the proximal sites, are satisfactory.[3]

Marginal fit of the crowns can be evaluated either qualitatively or quantitatively.[11] Qualitative evaluation is done by employing clinical or radiological methods whereas quantitative evaluation involves use of microscope at high magnification.[12] However, the use of such microscope is neither logistically possible nor clinically practical in routine dental practice.[13] Therefore, clinical methods involving visual inspection and use of sharp explorer are commonly employed in clinical practice. The assessment of margins is a relatively straightforward exercise on the buccal and lingual aspects. However, evaluation of interproximal and subgingival margins poses a clinical challege.[14,15] The detection of the marginal discrepancy of crowns largely depends on the skills and experience of the dentist.[4] The use of appropriate radiographs can overcome this limitation. Fattahi et al.[12] showed that upon radiographic examination, 75.5%

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crowns had vertical discrepancy at the margins and recommended the use of parallel radiography as an adjunct to the clinical examination for evaluation of proximal marginal adaptation. Libby et al.[16] evaluated the longevity of fixed partial dentures and suggested that periapical or bite-wings radiographs provided additional information regarding the marginal fit of restoration. Moreover, bite-wing radiographs were more valuable in the detection of proximal lesion compared to the periapical radiography.[17] It is not uncommon to observe that the margins of otherwise clinically acceptable crowns turned out to be inadequate when assessed radiographically. This led the current hypothesis that there is a difference in the radiographic and clinical acceptability of the crown margins. The current study was planned to radiographically evaluate the proximal margins of the metal-ceramic crowns that were otherwise clinically acceptable.

Materials and Methods

The prospective study was conducted at the dental clinics of Aga Khan University (AKU), Karachi, from July to December 2018. After approval from the institutional ethics review committee, the sample size was calculated using the World Health Organisation (WHO) calculator[18] with absolute precision 0.08, level of significance 0.05 and confidence level 0.95.

The sample was raised using non-probability convenience sampling technique from among metal-ceramic crowns of patients who had presented for single-unit crown placement in maxillary or mandibular arch. The patients were included after taking informed consent. Those who had lost their provisional crowns or had gingival inflammation or overgrowth around the prepared teeth were excluded.

All crown preparations were performed by restorative dentistry residents, with clinical experience of more than three years, under the supervision of consultants. A pre-cutting putty matrix composed of silicon rubber (Aquasil, Dentsply) was used to ensure appropriate tooth reduction in each case. Crown preparations were done for the metal-ceramic crowns with shoulder on buccal aspect, while rest of the margins were chamfer. The uniformity of margins and depth of preparation were ensured by using previously taken putty matrix for each preparation. Impressions of the prepared teeth were made with addition type silicone impression material in putty and light-body consistencies (Aquasil, Dentsply) using the single-step technique. These impressions were poured within 30 minutes with type IV high-strength dental stone using vacuum mixer (Bego stone plus, BEGO). Metal-ceramic crowns were fabricated with lost-wax technique using nickel-chromium alloy (Starloy N, Dentsply) as metal core followed by layering with ceramic (Ceramco 3, Dentsply). All crowns were fabricated by a single technician with experience of >15 years. Each crown was visually evaluated for marginal adaptation using its respective die by the restorative dentistry residents. The laboratory acceptable crown was taken to the clinic and was seated on the tooth preparation and was clinically evaluated using a sharp explorer along the margins of the preparation. The crowns that exhibited satisfactory marginal fits were deemed as clinically acceptable crowns. Once the clinical test was satisfied and no discrepancy was detected on clinical examination, radiographic assessment was done using the bite-wings. Digital image was obtained using complementary metal oxide semiconductor (CMOS) size 2 plate (XIOS XG, Sirona) with a help of a bite-wing film holder (XIOS holder system) and cone positioning guide to get the uniform bite-wing radiograph. This plate was then exposed at 70KVp, 7mAs, focus to distance 23cm for 0.10 seconds, using an X-ray unit (CS 2200, Carestream). The image acquired was transferred to imaging software Sidexis XG (Version 2.61, Sirona). Any discrepancy observed in the radiographic marginal adaptation was measured using a digital caliper on the imaging software Sidexis XG. A marginal discrepancy >0.05mm on the proximal sites was labelled as a "deficiency" on radiographic examination. The radiographic outcome of the crown margins was divided into four categories;no discrepancy, horizontal discrepancy (which may be a positive or a negative ledge), vertical discrepancy and a combination of horizontal and vertical discrepancy (Figure).

All radiographic evaluations were independently carried out by two calibrated examiners. Both examiners were trained for one week before the initiation of the project for the identification of marginal discrepancies on the bite-wing radiographs and the use of digital caliper on Sidexis XG (Version 2.61, Sirona) for the quantification of the discrepancy, if present.

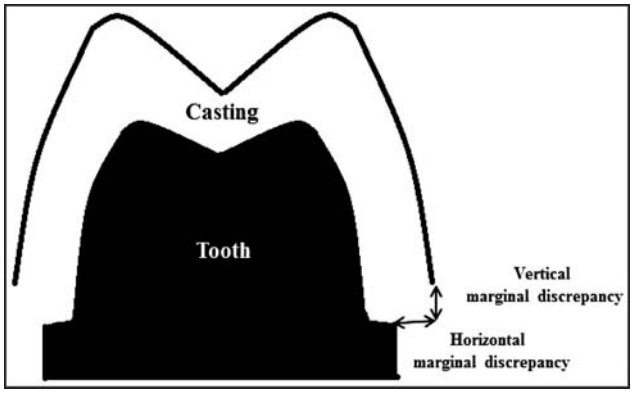

Figure: Vertical and horizontal marginal discrepancy between metal-ceramic crown and the tooth preparation.

Data was analysed using SPSS 22. Frequencies and percentages were calculated for tooth maxillary and mandibular teeth, mesial and distal tooth surfaces, clinical and radiographic assessment. Chi-square test was used to determine the association of marginal discrepancy of the crown with tooth type and tooth surface. Odds ratio (OR)was used to measure the association between the horizontal and vertical discrepancy categories of marginal discrepancy, and between the type of and site of tooth. Inter-examiner reliability was determined using intra-class correlation (ICC) coefficient. P<0.05 was taken as statistically significant.

Results

Of the 115 metal-ceramic crowns, 38(33%) belonged to mandibular teeth and 77(67%) were in the maxillary arch. Out of 230 mesial and distal sites assessed on the radiograph, 113(49.1%) had some form of crown marginal discrepancies (Table-1). The mean horizontal discrepancy was 0.08+0.35mm, while mean vertical discrepancy was 0.19+0.34mm. The vertical marginal discrepancies were mainly observed on the distal aspects of the crowns (OR: 8.2) whereas horizontal discrepancies were mainly seen on the mesial side of the maxillary crowns (OR: 3.0). These associations were statistically significant (Tables-2, 3). The inter-examiner reliability was excellent with ICC coefficient 0.93.

Table-1: Crowns and discrepancies (n=115 crowns).

Type of defect	Frequency (surfaces)	%
No discrepancy	117	50.9
Horizontal discrepancy	44	19.1
Vertical discrepancy	58	25.2
Both horizontal and vertical discrepancy	11	4.8
Total sites	230	100

Discussion

The null hypothesis was refuted in the present study. The radiographic examination exhibited horizontal and vertical marginal discrepancies in a large proportion of clinically acceptable crowns. This indicates significant difference in the two assessment methods. Ideally, there should be no difference in the clinical and radiographic assessments of the crown margins.[19] The presence of marginal discrepancy became a potential source for cement dissolution, microleakage and plaque accumulation which attract potential pathogens responsible for the development of carious lesions.[5,14,20-22] It is not only associated with the dental caries beneath the crown margins, but also with the caries in the adjacent teeth, leading to the failure of the fixed prosthesis.[8,23] For this reason, bite-wing radiographic technique was used to evaluate crown margins on the proximal surfaces in the present study.

Direct viewing technique is commonly employed at the chair-side that involves the use of dental explorer to evaluate the marginal fit of the crowns.[11] It provides valuable information regarding the presence of defects on the buccal and lingual surfaces, but it was not a suitable modality to detect any marginal defect on the proximal aspects of crown-tooth interface.[8,12]

The present study showed that clinical examination alone is not sufficient to label a crown as adequate. The radiographic assessment is superior in terms of deterring the marginal discrepancies, especially on the proximal sites. Relying solely on the clinical examination for the detection of marginal

Table-2: Association between tooth location and marginal discrepancy of metal-ceramic crowns observed on the bite-wing radiograph.

Tooth location	Radiographic Assessment				p-value
	No discrepancy	Horizontal discrepancy	Vertical Discrepancy	Both horizontal and vertical discrepancy	
Maxillary sites (n=154)	88	33	29	4	
Mandibular sites (n=76)	29	11	29	7	0.001
Total sites (n=230)	117	44	58	11	

*Chi square test was applied.
**Odds ratio between horizontal/vertical discrepancy and maxillary/mandibular teeth location turned out to be 3.0.

Table-3: Association between tooth surface and marginal discrepancy of metal-ceramic crowns observed on bite-wing radiograph.

Tooth surface	Radiographical Assessment				p-value
	No discrepancy	Horizontal discrepancy	Vertical Discrepancy	Both horizontal and vertical discrepancy	
Mesial	62	34	17	2	
Distal	55	10	41	9	<0.001
Total sites n=230	117	44	58	11	

*Chi square test was applied.
**Odds ratio between horizontal/vertical discrepancy and mesial/distal site of teeth turned out to be 8.2.

discrepancy resulted in the loss of marginal fit information in the proximal area of 50% sites.[12] Studies suggest that disparity exists among clinicians for the detection of marginal gap and the disagreement is there even within the subject assessed at two different times.[19,24,25]

Multiple studies proposed the use of radiographic aid in addition to the clinical examination for the detection of proximal marginal fit of fixed dental restorations.[12,16,26] Fattahi et al. recommended the use of periapical radiographs in addition to the clinical examination and proposed that the evaluation of marginal adaptation just with the use of explorer or even with the use of impression material was not sufficient.[12] Libby et al. advocated the use of radiography as a mandatory step in the crown and bridge cementation.[16] Durre and Ahmad had proposed the use of radiographs both before and after cementation for the detection of marginal discrepancies and presence of residual cement.[8] Such marginal discrepancies, when present, could lead to exposure of margins to oral environment, cement dissolution and plaque accumulation, which had adverse effects on both tooth and periodontal tissues.[8,27,28] Bite-wing radiographs were taken in the present study for the evaluation of the proximal marginal fit because it provided a near-parallel image of the abutment tooth.[29] This helped in obtaining practical information regarding adaptation of crown margins, its location and its relation to the crestal bone, thus, resulted in better treatment prognosis.[12] Although pre-cementation radiographs are not universally practised, data in the present study strongly suggests a case in its favour. For the present study, no unnecessary radiations were exposed to the patients as pre-cementation radiographic examination of fixed prosthesis is a standard operating procedure. Several studies have reported marginal gaps among crowns (detected radiographically or microscopically) that were earlier considered acceptable on visual examination.[23,30]

What constitutes a marginal discrepancy is debatable in literature.[11] According to Mclean et al.[31] marginal discrepancy <0.08mm was difficult to be detected under clinical examination. Another study showed that marginal opening of 0.1mm was detectable with dental explorer and was considered the borderline of acceptability.[24] Schaefer et al. described 0.05-0.15mm gap as acceptable marginal discrepancies.[32] Fattahi et al.[12] had considered the marginal gap >0.05mm to be an open margin. In the present study, a marginal gap of >0.05mm on bite-wing radiograph was treated as marginal discrepancy. However, there remains a lack of consensus on what constitutes a clinically acceptable marginal gap.

Does any configuration of the tooth preparation margin lead to inadequate margins in the definitive crown? The answer is not definitive. Although the present study has not evaluated the effect of marginal configuration on the marginal fit of dental restoration, as it was beyond the study's scope, literature suggests that large chamfer and tilted chamfer configuration are associated with higher marginal discrepancies compared to the shoulder preparation.[33] However, Tsitrous et al. were unable to detect any association between different marginal designs and marginal fit of dental restorations.[34]

The overall marginal discrepancies detected among clinically acceptable crown in the present study turned out to be 49.1% of the cases. This was better than reported by Fattahi et al. which showed marginal discrepancies in 85% of the cases when examined radiographically.[12] These discrepancies could be due to inaccuracy in the impression-taking by the clinician or improper handling of the dental casts by the dental technician. Durre and Ahmad evaluated patients with cemented crowns and bridges on periapical radiograph and found marginal discrepancies in 13-18% cases.[8] They attributed these discrepancies to improper tooth preparation technique, impression errors or casting defects.[6,8]

In the present study, out of around 50% sites of the defected margins, the horizontal discrepancy comprised nearly 20% of the sites, while 25% of the discrepancies were in the vertical plane. Only 11(5%) crowns had discrepancy in both dimensions. In contrast, Fattahi et al. detected horizontal discrepancies in 60% of the crowns, while vertical discrepancies were in 75.5% of the examined crowns.[12] The presence of vertical and horizontal discrepancies could be attributed to incomplete seating of crowns due to tight proximal contact or the presence of premature contact surface at tooth surface or fitting surface of the crown. It could also be due to inaccurate impression of prepared tooth because of the presence of blood and poor access of impression material to the prepared surface. The presence of subgingival margins could also be ascribed to the presence of crown marginal discrepancies.[12] Evidence suggests that marginal discrepancy is more common on the distal sites of the crown. This probably is due to difficulty in gaining access to the distal surfaces during tooth preparation.[8]

In terms of limitations, the present study was done at a single centre study and only metal-ceramic crowns on posterior teeth were evaluated, limiting the generalisability of the findings. Furthermore, bite-wing radiographs were not taken after the final cementation of the crowns, and, therefore, the effect of cementation could not be determined. The use of bite-wing dental radiographs should be used as an adjunct to the clinical assessment prior to the permanent cementation of the metal ceramic crowns on posterior teeth.

Conclusions

Almost 50% of the clinically acceptable crowns had some form of marginal discrepancy when evaluated on the radiograph. Vertical discrepancies were mainly noticed on the distal surfaces of the crowns irrespective of the arch, and horizontal discrepancies were mainly observed on the mesial margins of the maxillary crowns.

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RESEARCH ARTICLE

Rates of publication of FCPS dissertations in international and national peer-review journals among residents at AKUH; A cross sectional review of 15 years

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Abstract

Objective: To see the rate of publication of postgraduate residents' dissertation.

Method: The single-centre retrospective cross-sectional study was conducted at the Aga Khan University Hospital, Karachi, and comprised research publications from the residents of the departments of Surgery and Medicine who graduated between 2005 and 2020. The surgical subspecialties included Otolaryngology, Ophthalmology, Dentistry, General Surgery, Orthopaedics, Paediatric Surgery, Urology, Plastic Surgery and Cardiovascular Surgery. Data comprised demographics, current institution, current designation, information on dissertation/paper publication, topic of study, year of completion of dissertation, input from the research department, delay in exam due to incomplete dissertation and whether the paper got published in national or international journal. Data was analysed using SPSS 21.

Results: Of the 103 subjects, 70(68%) were males and 33(32%) were females, while 73(70.8%) belonged to surgical specialties and 30(29.2%) were from non-surgical specialties. Of the 22(22.9%) who were able to convert, 12(54.5%) publications were carried by national peer-reviewed journals, while 10(45.4%) were carried by international journals; 9(40.9%) unpaid peer review journals and 13(59.1%) paid journals. Delay in exam due to incomplete dissertation was faced by only 16(16.6%) candidates.

Conclusion: The rate of publication for resident dissertation was found to be low.

Keywords: Dissertation, Paper publication, FCPS dissertation, Residency, Synopsis. (JPMA 72: S-40 [Suppl. 1]; 2022)

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Introduction

According to Cambridge Dictionary, dissertation is defined as a long piece of writing on a particular subject, especially one that is done to receive a degree at a college or a university. According to the Accreditation Council for Graduate Medical Education (ACGME) guidelines, it is necessary for a residency programme to design a curriculum that helps the resident to excel in the knowledge of basic research principles, and ensures participation in the research process.[1] Reporting of resident scholarly activities, national and international presentations and publications are required under the ACGME guidelines.[1] Majority of postgraduates (PGs) in the field of medicine work as pure clinicians and are either less oriented or too preoccupied with clinical duties to perform research.[2,3] Moreover, there is a significant difference in research activities of residents in terms of their place of practice. Community-based government-run programme residents are less likely to publish than those working in private hospitals.[3] In Pakistan, the College of Physicians and Surgeons of Pakistan (CPSP) calls for mandatory research activity that the residents should undertake before they take up their exit exam. A synopsis of the proposed project is conceived by the candidate with the help of the supervising faculty at the teaching hospital. Once approved, the synopsis can form the basis of the future project in the form of a dissertation. This dissertation is then peer-reviewed by the Research, Training and Monitoring Cell (RTMC) at the CPSP. Only after this dissertation is made acceptable to the set standards, the candidate can appear in the exam. Another route to establishing a scholarly aptitude in graduating residents is to have at least two published papers in PubMed-indexed journals related to their specialty. To date, dissertation remains not only one of the most integral part of postgraduate medical education in Pakistan, but also qualifies as the most commonly adopted route to scholarships by medical trainees.[4]

The whole idea of inoculation of dissertation in postgraduate education is to teach the residents to formulate a research question, collect prospective data on the patients, present their research data as a work in progress, and come up with a conclusion as a dissertation on a given template.[5] It helps to promote evidence-based skills and enhances critical analytical thinking, which, in turn, have a positive impact on clinical practice.[2]

Medical research writing is not yet fully developed in

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Pakistan.[4] Most medical schools in Pakistan have inadequate teaching about the basic concept of medical research.[4] After the initiation of fellowship diploma by the CPSP, the residents have to gain knowledge base, adjust into the hospital environment, learn patient care, and develop surgical skills.[4] During this transition phase, a resident has to search literature to select a topic and come up with a synopsis proposal. At that point, the whole idea of synopsis writing comes as a formality that has to be done.[4] It is not mandatory to publish the dissertation, but it is one of the aspects that defines the quality of study done[5] in a comprehensive manner to address the pertinent issue, and its possible solution for a positive change in the existing practices.

Educational environment and designated research time has a great impact of productivity in residency.[1] There is a noteworthy positive interdependence seen in research productivity of departments with dedicated research hours, research funding and travel support.[6] In the evaluation of 1690 orthopaedic residents by Williams et al., remarkable parallelism was seen in the number of publications and dedicated research time.[6,7] Unexpectedly, having research publication as a requirement (for example, dissertation or two paper publication as per the system in Pakistan) has almost no correlation with academic productivity or increased interest in research.[6] According to a paper published in Turkey, publication rate of dissertation topic/thesis ranges from 1.2% to 53%.[5] In Pakistan, there is severe paucity of data on the subject.

The current study was planned to evaluate the rate of publication of residents' dissertation.

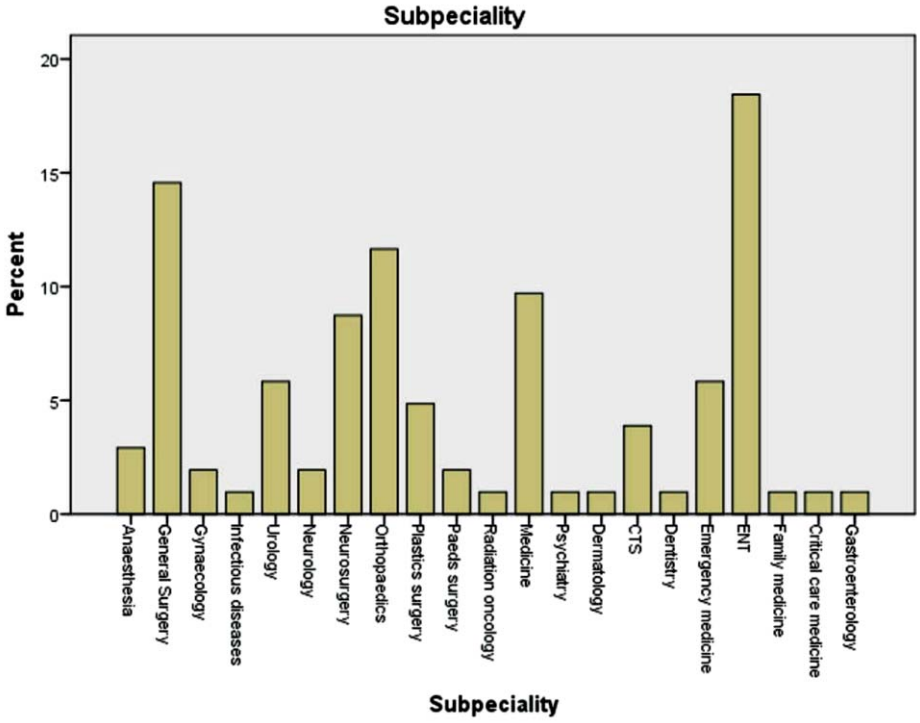
Materials and Methods

The single-centre retrospective cross-sectional study was conducted at the Aga Khan University Hospital (AKUH), Karachi, a tertiary care teaching hospital with more than 700 beds. The study comprised research publications from the residents of the departments of Surgery and Medicine who graduated between 2005 and 2020. After exemption from the institutional ethics review committee (ERC), a list of residents having graduated during the target period was obtained from the Department of Postgraduate Medical Education (PGME). All the residents were approached Using Google survey facility along with the consent form. Those who did not want to participate were excluded.

The data gathered included demographics, current designation, institution, current designation, information on dissertation, paper publication, topic of their study, year of completion of dissertation, help from the research department sought or not, and delays in exam due to incomplete dissertation. In case the paper was published, it was asked if the publication was a national or international peer-reviewed journal. If it was not published, possible reasons of failure were determined. The title of their research was obtained and checked online on PubMed and Goggle Scholar for publication. Data was de-identified and was entered on an Excel sheet for statistical analysis. Data was analysed using SPSS 21. $P<0.05$ was considered significant.

Results

Of the 290 residents, 103(35.5%) returned the survey form; 70(68%) males and 33(32%) females. A wide variety of subspecialties were represented in the sample (Figure). Of the 103 participants, 58(56.3%) were currently employed at AKUH, while 45(43.7%) were working elsewhere. There were chief residents 28(27.2%), registrars 18(17.5%),



CTS: Cardiothoracic Surgery, ENT: Ear-Nose-Throat.

Figure: Specialty distribution.

Table: Specialty-based categorisation and publication rates.

Dissertation Status	Surgical Candidates (n=73 70.8%)	Non-Surgical Candidates (n=30 29.2%)
Published	21(28.7%)	8(26.6%)
Not Published	52(71.2%)	22(73.3%)

fellows 15(14.6%), consultants 14(13.6%), instructors 13(12.6%), assistant professors 14(13.6%) and associate professor 1(1%) in the sample. Overall, 73(70.8%) subjects belonged to surgical specialties and 30(29.2%) were from non-surgical specialties.

Of the 96(93.2%) subjects who opted for dissertation writing, 74(77%) were not able to convert their dissertation into publication; 52(70.2%) from surgical specialties and 22(29.7%) from non-surgical specialties (Table).

Of the 22(22.9%) who were able to convert, 12(54.5%) publications were carried by national peer-reviewed journals, while 10(45.4%) were carried by international journals; 9(40.9%) unpaid peer review journals and 13(59.1%) paid journals. Delay in exam due to incomplete dissertation was faced by only 16(16.6%) candidates.

Of the total, 7(6.8%) participants had chosen publications rather than dissertation. Among them, 4(57.1%) faced a delay in their exams, and 4(57.1%) opted for an international, paid, peer-reviewed journals.

Discussion

The intention behind postgraduate academic activities is to inculcate the research culture amongst the new crop of clinicians and surgeons. The ultimate goal of writing dissertations is to get them published in peer-reviewed journals.[8] Traditionally, dissertation has been a part and parcel of the residency structure, but a transition has been observed.[9] In 2009, the CPSP gave the PGs the option to either do a dissertation or to publish two scientific papers in a PubMed-indexed journal after topic approval.[4,9]

The current study found an inclination among the PGs toward dissertation. It was chosen by 96 residents, and 80 of them completed the assignment in time, but only 22 were able to convert it into a publication; the publication failure rate being 77%. A study in India reported a publication rate of 32.5%.[8] In the current study, 70.2% surgical residents failed to get their dissertation published. A possible explanation is a compromise on surgical training which is behind the reluctance towards the research culture.[10]

A typical resident comes across numerous impediments during struggle for publication which may or may not stem from choices.[11] The current study found that lack of interest in research and publication, difficulty managing timelines, lack of funding, and shortage of time to collect data were the most prevalent hurdles for conversion of dissertation to publication. In contrast, literature has suggested that delay in publication rates were likely due to choosing journals not befitting the category of academic work, poor understanding of the submission guidelines and not fully appreciating the research intricacies.[12] In another study, the major impediments included political reasons, language-related problems, shifting priorities and the lack of academic writing guidance.[11] The current study highlighted that dedicated research slots, workshops and research courses were the factors affecting positively, but in an Iranian study, the most significant motives included the students' desire to publish their works for their graduation, padding their resume, to meet the academic institutions' requirements, and, lastly, to further promote their work and extend knowledge beyond the confines of their region.[11] Only 7 residents in the current study chose the option for getting two publications, and all of them were able to get their papers published, but the process of publication was completed in time by only 3(42.9%), and 4(57.1%) had to face exam delay.

To increase the scholarly yield of the residents, some of the programmes offer a dedicated year of research during the residency training. In this way, the residents get guaranteed time to experience basic or clinical research in the initial part of their careers.[13] The research-track residents were more likely to publish than the traditional-track trainees. Moreover, those who published in peer-reviewed journals during their residency programmes were more likely to publish in the later years of their professional life.[14] Similarly, interventions to increase the scholarly potential of the residents in training have been associated with better outcome.[15]

The limitations of the current study included the inability to take a homogenous sample size from the various specialties and their uniform temporal distribution. Moreover, potential confounders, like institutional bias, could not be addressed as it was a single-centre study.

Conclusion

There was a low rate of conversion from dissertation to publication. It is a significant shortcoming and a potential area of improvement of the said residency programme. Further research at national level is needed to determine the factors affecting publication rates among residents.

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ANALYTICAL STUDY

Otorhinolaryngology consultations in a multidisciplinary hospital — their effects on residents training on floor

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Abstract

Objective: To determine all types and severity of Otolaryngology consultation requests at our tertiary care center and spectral records of problems related to otorhinolaryngology come across initially by residents which will help in re-shaping residency programmes and enhance patient related care.

Methodology: All otorhinolaryngology consultation received over a three-month period were recorded prospectively. Information collected for each encounter included the time, date, reason for consult at primary service and admission with final ENT diagnosis, any surgical or non-surgical intervention, and basic patient demographics.

Results: A total of 127 consults for inpatients were reviewed from April 2020 to June 2020. Out of total, 84 (66.1%) patients were male and 43 (33.8%) were females. Adult patient consultations amounted to 87(68.5%) while 18(14.1%) were in the age range of 6-18 years. Only 4(3.1%) consultations were raised for neonatal patients. Routine consultation were had for 64(50.3%) while 45(35.4%) patients were reviewed as an emergency. Operative interventions were required by 43(33.8%) among which tracheostomy was the most common operative procedure performed in 26(20.7%) patients. If we broadly classified ENT consultations, 40 (31.4%) were of problems related to head and neck region while 38 (29.9%) were related to the laryngology sub-specialty. Most common consultation was for airway assessment in 26(20.7%) patients followed by otorrhoea, in 15 (11.8%) patients.

Conclusion: In inpatients, upper airway assessment, aural discharge and epistaxis were the most frequent complaints for seeking ENT review. This study should prove to be beneficial in forming a curriculum of educational programme for junior residents.

Keywords: Residents training, Consultations, Otorhinolaryngology, Multidisciplinary hospital, Workload. (JPMA 72: S-44 [Suppl. 1]; 2022) **DOI: https://doi.org/10.47391/JPMA.AKU-20**

Introduction

In a large multispecialty hospital, subspecialty consultations play a pivotal role in comprehensive medical care. Appropriate consultation requests placed in both the inpatient and emergency department settings, provide patients with an opportunity to access necessary care and relevant management of their problem by a specialist doctor.[1] Consultation patterns of various surgical specialties such as orthopaedics, urology, vascular surgery and orthopaedic surgery have been reported in literature[2,3] but data regarding otolaryngology/ENT consultation is limited especially in our part of world.

ENT consultations are ordered from ED, ICUs and wards. They have been divided into categories of emergency, urgent and routine requests. Emergencies require immediate attention and intervention which include airway compromise, epistaxis or foreign body impaction, and urgent requests require timely consultation, including cases of inflammation and infection. Routine requests are for consultation of any acute or chronic condition including earache, vertigo or dizziness, among others.[4,5] Usually, ED consultations are given priority and are raised and seen on urgent basis.[6]

Overall, a rise in on-call ENT consultations has been noted. This poses a challenge to proper patient access, physician workloads, and resource allocation.[4] However, a significant problem arises with mismanaged consults as they increase the workload for on-call teams of that specialty as well as lead to poorer patient outcomes due to subsequent improper treatment.[7] This occurs more in overcrowded hospital wards specially in Emergency Departments where a significant number of patients with ENT complaints do not require ENT consultation but rather direct departmental management.[5] Due to lack of data on patterns of in-hospital consultation for common complaints, and low knowledge on management skills of emergency cases, there is a dire need to identify the causes for rectification.[8]

This study will quantify and analyze inpatient consultations, their complexity and ultimate need of any intervention required in a tertiary care Centre. Eventually a

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pattern for training the in-hospital staff and manage the consultation process to ensure efficient interdepartmental functioning will be evolved.

Methods

A cross-sectional study was done in otorhinolaryngology section of Aga Khan University Hospital, Karachi after taking an exemption from Ethical Review Committee (ERC). All ENT consultations, including inpatient, raised over a period of 3 months from January 2021 to March 2021 was recorded prospectively. Non-probability consecutive sampling was used for collection of data.

Apart from basic demographic details of patients, the details of each request included the nature of consult, the requesting department, the post consultation diagnosis, and any intervention given. Duplicate consultation consults for dental problems, incorrect surgical service, consultations, records with insufficient information and consultations raised from emergency department were excluded.

All data was accessible only to the primary investigator and identity of all patients was protected by assigning a study code to specific medical record number.

At our center, all Otorhinolaryngology consultation requests assigned to the department, are received on a consult pager. All this data is recorded daily before morning rounds. The same manner was applied to collect this data and there was no interaction with any patient on this account. The on-call ENT team comprises of a senior resident (PGY-III or above) and a junior resident. All consultations are usually first seen by junior residents followed by assessment from a senior resident thus making junior residents as the first responders of any consultation. All Consultations are reviewed by attending to them either on the same day or next day, depending upon the nature of the problem. All consults are evaluated by faculty either on the same day, or within a 24-hour period, depending on the urgency level of the consult. All consultation requests are given a management plan after discussion or once reviewed by attending consultant assigned as per consultant on-call Rota.

Data was categorized based upon nature and reason of consultation, age groups and type of Otorhinolaryngology intervention. Data Analysis was performed using software SPSS version 23. Characteristics of consultation were described in various categories such as age groups, gender, nature of consult and all the categorical variables were calculated as frequency and percentages.

Results

A total of one-twenty-seven consultation requests were raised during the period of 3-months. Out of the total, 84(66.1%) patients were male and 43(33.8%) were for female patients. For ease of data analysis, we divided patients in range of following age groups, neonatal group, infant group, 1 year to 6 years, 6 years to 18 years and adult group of patients. Adult consultations were for 87(68.5%) while 18 (14.1%) patients were in 6-18 years of range. Only 4 (3.1%) consultations were raised for neonatal patients. Routine consults were 64(50.3%)

Table-1: Reason of consultation.

Reason for Consultation	Consults (n= 127)
Airway Assessment/Stridor	26 (20.4%)
Otorrhoea	15 (11.8%)
Neck Swelling	12 (9.4%)
Hearing Loss/Tinnitus/Vertigo	12 (9.4%)
Sinus Infection	11 (8.6%)
Epistaxis	10 (7.8%)
Decannulation of Tracheostomy	09 (7.08%)
Ear Blockage/Ear Wax	07 (5.5%)
Oral Bleed	06 (4.7%)
Sore Throat	05 (3.9%)
Otalgia	05 (3.9%)
Foreign Body ENT	03 (2.3%)
Accidental Dislodgement of tracheostomy Tube	02 (1.5%)
Others	04 (3.1%)

Table-2: Type of intervention.

Type of intervention	Total Consults (n=127)
Operative	43 (33.8%)
Non-operative	84 (66.1%)

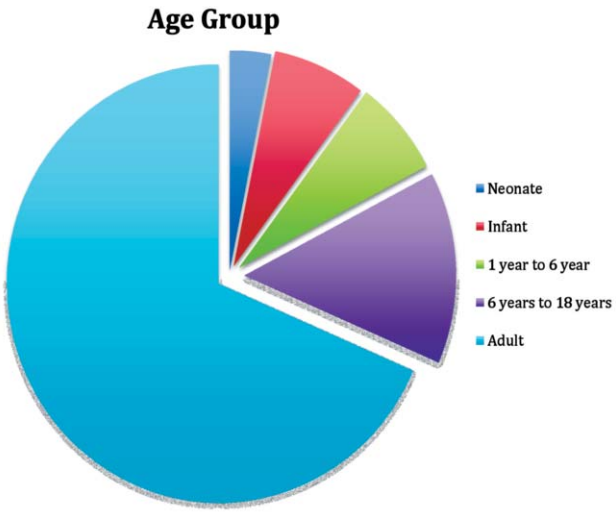

Figure-1: Age group of patients needed ENT consultations.

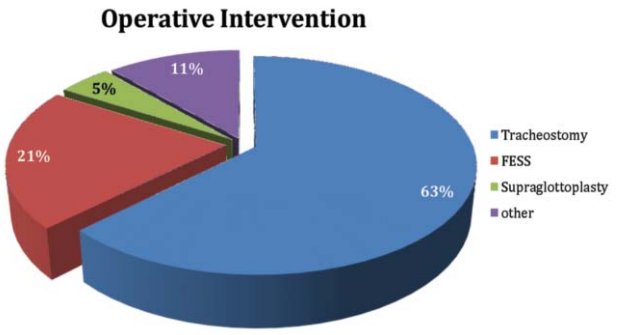

Figure-2: Operative intervention procedure.

which were seen within 24 hours while 45 (35.4%) patients were reviewed as an Emergency. Operative interventions were required by 43(33.8) patients with tracheostomy being the most common operative procedure done in 26(20.7%) patients. If broadly classified ENT consultations, 40 (31.4%) were of problems related to head and neck region while 38 (29.9%) were related to laryngology sub-specialty. Most common consultation was for airway assessment in 26(20.7%) patients, while second most common was of otorrhoea in 15(11.8%) patients.

Discussion

An in-house otorhinolaryngologist cover at all times is essential for a tertiary care hospital. For a well-rounded service, subspecialty consultation is of utmost importance. This elevates the care of patients to a multimodality level thus enabling the primary care physicians to approach and treat patients with multiple issues. The importance of otolaryngology in primary care has been already established.[9,10] Common complaints usually include various acute and chronic ear symptoms as otitis, spinning sensations, airway, nose, neck and throat related issues, hoarseness, and nasal bleeding. Common complaints generally include various acute and chronic ear diseases, such as otitis media, spinning sensations and problems related to the airway like stridor. Symptoms related to the voice as hoarseness, to the nose like epistaxis and to the neck. These are widely prevalent in our population leading to an increased burden on health care.[5,9,11] Otorhinolaryngology complaints are responsible for 20 percent of all presentations to primary care centres in adults and up to 50% in paediatric patients.[4,9,10] With increasing mismanagement in inpatient clinics, patients come for common complaints to the emergency, where ENT consults are placed. This increases workload as well as affects resource allocation which is negatively impacting health care.[4]

The trends seen in consults are different worldwide. Especially since the COVID pandemic, their concerns have increased to be the most in intensive care units. Shomoroney et.al reported it to be 54% of all consults received. Among the categories of consultations, the recent trend has also shifted to most cases being referred for airway management in particular for tracheostomy, and rhinology especially fungal sinusitis.[12] This is consistent with management of COVID and post covid sequelae.

A lack of knowledge has been identified in primary care practitioners in being able to deal these issues directly.[13] Currently, in the residency programmes, management of common issues have been included, besides those specific to the specialty. But the aspects of basic otorhinolaryngology training in the overall curriculum has been overshadowed by inconsistency and a lack of structure in residency programmes. The focus has been placed on evidence-based practice.[14] Due to this deficiency of expertise in management, the consults get postponed, instead of receiving direct management. Furthermore to develop a high quality care and patient centric services for otorhinolaryngology, improved education and training is of pivotal importance. It will also enable residents to deal with basic otolaryngological issues, instead of writing referrals.[14,15] Hence increased teaching should be made during medical school and residency.[8]

There is not much of literature regarding otolaryngologic consultations in a tertiary care setting. For the ENT trainees, a consult is an "unplanned" clinical activity. Nevertheless, they are indispensable for patients with airway emergencies. While available for other specialties, sparse literature is present highlighting the importance of this "hidden" workload of an otorhinolaryngology resident, which can have an effect on their performance.[4,16,17] In a cross-sectional retrospective study, Kristine Smith et al demonstrated significant increase in the volume of consultations to on-call resident at a tertiary care center and she concluded that this load has the potential to adversely affect patient care.[4] Otorhinolaryngologist must be accessible since they cover different sites, and urgent versus emergent services are required on a nearly daily basis. If this accessibility is limited, then hospital discharge could be delayed unnecessarily, leading to additional negative consequences.[18,19]

Our study reviewed characteristics of ENT consultation raised for in-patients in a tertiary care setting and includes nature of consult and whether it needed any intervention or not. The four most common reasons for ENT consultations were upper airway evaluation, otorrhoea, neck swelling, vertigo, and sinusitis.

Furthermore the most common operative intervention done in our patients was tracheostomy. New residents are often uncomfortable performing flexible laryngoscopy, anterior nasal packing, decannulation and change of tracheostomy tube. Most consultation requests, once placed, are initially seen, and managed by the junior residents, who invariably require assistance from the senior residents for simple bedside procedures. It is not only increasing the workload at all residents' levels but also increasing cost of health care provision on patients in a low middle-income country. In a similar study conducted at department of otorhinolaryngology SUNY upstate medical university, New York, Erica et al[20] retrospectively reviewed patients who received ENT consultations from 2014 to 2018. In this series 8806 consults were noted. They concluded that increasing burden on emergency department consultations on ENT service at academic medical centers highlights a potential cause for increasing and improving provider availability. However, frequent and unnecessary inpatient consultation can significantly increase workload of on-call residents and overall services.

Patients with non-emergency issues like ear discharge, allergies, or hoarseness are identified as common reasons of consultations. These problems can be better assessed and sorted in the clinical setting, suggesting further towards the presence of unnecessary consultations. We recognize that while the true necessity of a consultation is subjective, the need for ENT intervention is a more quantifiable surrogate to determining the overall relevance of the placed consult. In our series, 84 (66.4%) consults did not require any operative or bedside intervention. We did an operative intervention on 43(33.8%) consultations and most performed procedures were elective tracheostomy done on 26 (20.7%) patients while 5(3.9%) underwent endoscopic sinus surgery. This is consistent with the research done in other regions, showing a need for change in managing the consultation process.

Thus, it is suggested that for most common encounters, including basics of tracheotomy care, flexible laryngoscopy, expertise in interpretations of scans of head and neck region and the method required to perform it, anterior and posterior nasal packing, among others, management teaching should be started immediately. Having residents better equipped to deal such encounters themselves will refine the consultation process and improve the balance of workload.

Conclusion

Although our study is based on a single tertiary care setting but it can definitely impart a significant contribution to the scanty literature present on this topic and it can be used to design educational curriculum not only for residents in ENT training to have command on commonly encountered consultations but also for other services in order to have enough knowledge of basic otorhinolaryngology problems so unnecessary consultations and referral and ultimately patient's hospital stay can be lowered down.

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SYSTEMATIC REVIEW

Role of simulation in open varicose veins surgery: A systematic review

Muhammad Ammar Pirzada, Fareed Ahmed Shaikh, Shoaib Badini, Nadeem Ahmed Siddiqui

Abstract

Objective: To assess the types and effectiveness of simulators present for open varicose vein surgery.

Method: The systematic review was conducted at The Aga Khan University Hospital Karachi and comprised studies published from 1st January 2000 to 30th June 2020 related to open varicose vein surgical procedures done on simulators. Databases searched were PubMed, Medline, Google Scholar, Cochrane and Scopus using appropriate key words. The primary outcome of the review was to assess the effectiveness of different types of simulators used for varicose vein surgery.

Results: Of the 286 articles found, 6(2%) were included. A variety of simulators ranging from animal models, homemade simulators and commercially designed models with high fidelity options had been used. Technical competence was the major domain assessed in most of the studies 5(83.3%), while 1(16.6%) study focussed on self-assessment. Blinding was done in 4(66.6%) studies for assessment purpose, and videorecording of the trainees' performance was done in 5(83.3%) studies. Most studies 4(66.6%) found the use of simulation to be an effective tool in achieving technical competence.

Conclusion: The use of simulation in the training of surgical residents for open varicose vein surgery was found to be beneficial, but most studies were heterogeneous in terms of design, simulator types and study participants. This makes it difficult to establish the superiority of any one type of simulator over the rest. Further research is needed to develop and validate simulators in open varicose vein surgery procedures.

Keywords: Simulation training, Surgical education, Surgical training, Varicose vein surgery, Assessment, Saphenofemoral junction disconnection.

DOI: https://doi.org/10.47391/JPMA.AKU-10

Introduction

Acquiring operative skill proficiency is the most important aspect of surgical training. Recently the concept of residents; training on real patients has been seriously questioned.[1] The 80-hour-a-week regulation has decreased the operating exposure of the surgical trainees, making it imperative to maximise learning in limited time.[2] This has been further compounded by shortened duration of surgical residencies.[3] Fear of potential lawsuits has also not helped the cause.[4] Lastly, the widely popular approach of minimally invasive surgeries has resulted in endovascular training getting more attention than its open counterpart.[5] This has opened an avenue to discuss the emerging role of simulation, particularly for open vascular surgical procedures.

A simulator is a model or a set of equipment designed specifically for training by replicating situations encountered in real life.[6] Globally, there is a major shift in favour of simulation for safe training and fine-tuning of skills.[7] Simulators, being cost-effective, readily available, easily commutable and with repeatability of usage, have an edge over other forms of training.[8] It also avoids the ethical dilemma that the trainers might face in terms of putting a patient's safety at stake for training the trainees.[9] Another challenge for the trainers is the assessment of a trainee's skill level. Direct observation in operating rooms (ORs) lacks objectivity and is associated with potential limitation of different interpretation between observers for a similar set of skills.[10]

Varicose veins (VVs) represent a common pathology[11] with reported worldwide prevalence ranging 10-30%.[12,13] Khan et al. reported a prevalence of 34.8% for chronic venous insufficiency (CVI) in Pakistan.[14] Traditional treatment has been surgery, which involves saphenofemoral junction disconnection (SFJD) in the groin.[15] But now endovascular techniques are gaining popularity for the treatment of VVs.[16] The trainees now are more used to the endovenous procedures, resulting in limited exposure to open SFJD. Even with all the advancements and frequent use of endovascular approach, there may be situations where open SFJD needs to be performed. Reluctance of health insurances to cover CVI forces patients to opt for open SFJD which is cheaper than endovenous procedures.[17] VVs surgical procedures are associated with potential complications, like intraoperative bleeding, haematoma, groin infections and recurrence. If the operating surgeon has not been trained adequately and had limited exposure to SFJD

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during training, the likelihood of having intraoperative and postoperative complication is increased. All of this makes it imperative that the skill of performing VVs surgery be mastered by the trainees.

Use of simulation for open vascular surgery procedures is widely reported. Although different types of simulators with varying fidelity are available but utility of any particular simulator over others is an unexplored area.[18] This poses a problem for surgical educators in deciding the best approach and simulation technique that is cost-effective and ensures performance enhancement for VVs surgery.

The current systematic review was planned to assess literature on the type of simulators available and their effectiveness for technical performance of the trainees in VVs surgery.

Materials and Methods

The systematic review was conducted at The Aga Khan University Hospital Karachi from 30th June 2021 till 30th July 2021 and comprised studies published from January 2000 to June 2020 related to open VVs surgical procedures done on simulators. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement,[19] studies were searched on PubMed, Medline, Google Scholar, Cochrane databases and Scopus search engine. Studies, including case reports as well as observational and interventional studies, discussing the scope of simulation in VVs surgery were included. Studies related to simulation in vascular anastomosis or other non-VVs vascular procedures were excluded. Review articles, ongoing studies, unpublished articles and studies that were not published in the English language were also excluded.

The search strategy comprised the population, intervention and outcomes model.[20] Population was identified as physicians being trained in the discipline of vascular surgery. Both independent vascular surgeons and trainees were included. The terminologies used for this purpose were "vascular surgery trainees" OR "fellows of vascular surgery" OR "consultant vascular surgery" OR "attending vascular surgeons" AND "open vascular surgical procedures" OR "open vascular surgery". Various simulation models being used for open VVs surgery were considered as the aimed intervention. The terms included were "simulation models" OR "simulation tools" OR "simulation training" OR "simulation in open varicose vein surgery". The outcome was the effectiveness of different types of simulators used for open VVs surgery training. For such outcome, search terms included "effectiveness" OR "efficacy" OR "usefulness" OR "Impact" OR "benefits" OR "role" AND "simulator types" OR "simulation in open varicose vein surgery".

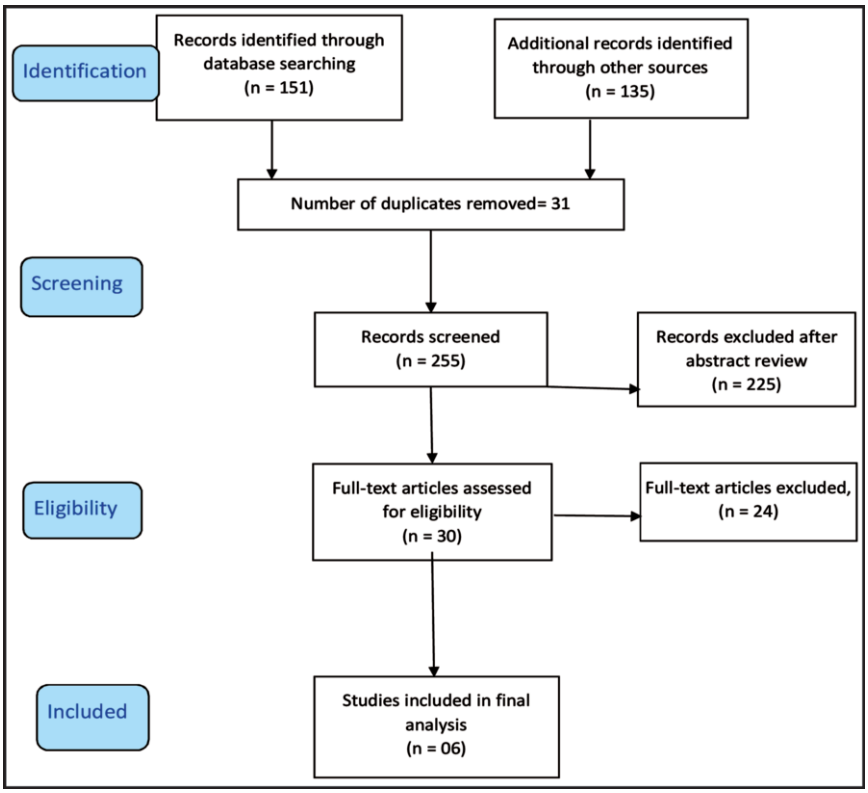

Figure: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow-chart.

All studies mentioning the role of simulation in VVs surgery irrespective of the type of simulation used were included. Descriptive studies and review articles related to the role of simulation in VVs surgery were excluded. The identified studies using the above-mentioned criteria were reviewed by two independent investigators who thoroughly reviewed the search items. In case of disagreement between the reviewers, an independent third reviewer was invited to address the issue. For initial scanning, the titles of relevant studies were looked at and duplications were excluded. This was followed by rigorous evaluation of abstracts and manuscripts of the finalised studies to complete the process of inclusion. To avoid missing any relevant study, references of all the included studies were also reviewed.

The primary outcome was to assess the effectiveness of various simulation models used in VVs surgery training. Data noted on a predesigned template included publication year, details of the publishing journal and authors' names from the selected articles. Variables related to simulation, like the nature of simulator, details of the participants, including their number, training levels, assessment strategies and effectiveness of the simulation models, were also recorded.

The quality of studies was assessed using the validated National Institute of Health (NIH) tool.[21]

Results

Of the 286 articles found, 151(52.8%) were identified through the databases, while 135(47.2%) were found through other sources, like references of articles identified through database search. After the screening process, 6 (2%) studies were included for detailed review (See PRISMA diagram). Because of the difference in the reported outcomes and heterogeneity in the methodology in different studies, it was not possible to perform meta-analysis.

The mean NIH score of all the included studies was 7.3 ± 0.372. The mean number of participants was 26.5± 9.725. The level of training, technical capability and surgical experience varied widely[18,22-26] (see Table). A variety of simulators ranging from animal models, homemade simulators and commercially designed models with high-fidelity options had been used. Technical competence was the major domain assessed in most of the studies 5 (83.3%), while 1 (16.6%) study focussed on self-assessment. Blinding was done in 4 (66.6%) studies for assessment purpose, and videorecording of the trainees' performance was done in 5 (83.3%) studies. Most studies 4 (66.6%) found the use of simulation to be an effective tool in achieving technical competence. Overall, 3 (50%) studies grouped participants into junior residents, senior residents and consultants.[18,24,25]

Moorthy et al.[24] created an artificial scenario leading to a crisis situation while dissecting the SFJ and the trainee's response in terms of handling the bleeding from the femoral vein was assessed. Performance was individually assessed and feedback was generated. Assessment was two pronged, analysing human factor skills and bleeding control skills. Time management was also considered. Blood loss was investigated as surrogate outcome measure. Two surgeons and a human factors expert assessed the trainees in a blinded manner. Trainees were grouped in two blocks, senior and junior trainees, depending upon the number of SFJDs performed previously.

Beard etal.[26] did not specify simulator details while evaluating 33 trainees from the General Surgery department. Five skills, including vessel ligation, were evaluated in a simulation setting. The operative skill of each participant was then investigated during SFJD on two or three occasions by a single surgeon observer. However, the exact nature and construct of the model

Table: Summary of articles included in the systematic review.

Paper	Year of Publication	Number of Participants	Type of Simulation Model	Domain Assessed	Assessment Done	Assessment Tool	Outcome	NIH Score
Hseino[22]	2012	12 Junior trainees	Bench model simulator	Technical skills	Yes (blinded)	Not reported	Beneficial	7
Pandey[23]	2008	42 Senior trainees (at the end of training)	Bespoke synthetic model	Technical skills	yes	Modified GRS	Not reported	7
Datta[25]	2004	Total 22 Consultants-4 Specialist- 14 Senior HO - 4	Inanimate synthetic model	Technical ability	Yes (blinded)	OSATS	Beneficial	8
Moorthy[24]	2006	Total-20 Senior trainee-10 Junior trainee-10	Silicone based synthetic model	Technical skills / crises management	Yes	GRS, NOTECHS rating scale	Beneficial	7
Pandey[18]	2012	Total-30 Candidates-22 Examiner-8	Bespoke synthetic model model	Technical ability	yes	OSATS, ICEPS	Not reported	7
Beard[26]	2005	33 General Surgery Trainees	Not known	Technical skills	Yes, blinded	Task specific checklist	Beneficial	7

GRS: Global rating scale, OSATS: Objective structured assessment of technical skills, NOTECHS: Non-technical skills, ICEPS: Imperial College Evaluation of Procedure-Specific Skill.

used for simulation was not explained. Pandey et al.[18,23] in 2 (33.3%)studies used Bespoke synthetic groin models for SFJD.

Different types of validated and partially validated assessment tools were used, like the objective structured assessment of technical skills (OSATS), and the modified global rating scale (GRS).[23,24] Beard et al.[26] used task-specific checklist for assessment purpose. Of the total, 3 (50%) studies[22,25,26] reported assessors being blinded during assessment of the video recordings. Pandey et al.[23] identified significant variability in assessment between the independent observers and trainees assessing themselves as self-assessment. Therefore, the study recommended regular technical feedback during training to ensure improvement in technical performance of the trainees.[23]

Pandey et al.[18,23] did not highlight the usefulness of simulation, as the objective of both the studies was different and the focus was on participants' self-assessment and establishing comparison of relationship between technical and oral performances.

Discussion

The current review identified some interesting facts regarding the role of simulation in VVs surgery. The development, advancement and use of simulators in endovascular interventions has surpassed the simulation in open vascular surgical procedures.[4] The findings point toward the fact that despite VVs surgery being one of the most performed procedures, the work on simulation for residents' training is limited and is further complicated by the fact that almost all the present studies are heterogeneous in nature with different types of simulators used in a limited number of participants.

The objective of a simulator is to create an environment with certain element of fidelity for the behavioural, emotional and cognitive engagement to ensure effective participation, resulting in desirable outcomes.[27] The types of simulators ranged from a simple plastic-based synthetic model[25] to a more complex Bespoke model[23] and finally to a very complex simulated operating theatre (SOT).[24] The effectiveness of training on simulators of varying fidelity is still a matter of debate.[28] Moorthy et al. used SOT with the involvement of an anaesthetist, and focus on blood-loss, realisation of calling for help along with the procedural technicalities showed indirect benefit of simulation. Majority of participants in the study thought of simulation as useful for skill acquisition.[24] However, other studies[25,26] also reported simulation as a positive catalyst for the improvement in surgical skills while using comparatively low-fidelity models. Different types of simulation models were used across all studies. This limitation along with quite a low number of studies on this subject limit the ability to conclude any one model being superior to the others. It can be assumed that the experience of simulation in VVs surgery can be enhanced by using cadaveric models with intact perfusion. These models have been used in certain institutions to enhance the simulation experience for open vascular surgery procedures.[29]

All the studies included had a wide variation of participants. Even though the numbers ranged from 12 to 42, the experience and designation of these participants were quite variable, ranging from surgical trainees at different years of training from the first year to candidates for European Board Fellowship to consultants already practising independently. With each year of training, the learning needs of the trainees differ and the complexity of the procedures also do not remain the same.[17] Low-fidelity simulators, such as bench top plastic models, may appear to be highly useful for junior trainees in the first or second year of their training, but for the senior group of trainees, incorporation of more complex aspects of surgical skills is needed. As of now, there is not enough evidence to ascertain the advantage of high-fidelity over low-fidelity simulators for senior trainees.

Prior exposure to VVs surgery before becoming a part of simulation is another factor to consider in terms of effectiveness of training. Again, there is heterogeneity where Hseino et al.[22] inducted 12 participants in the first and second year of training with no prior exposure to VVs surgery, while Moorthy et al. included only those participants who had done at least 20 cases of SFJD before.[24] The trainee's previous exposure can substantially enhance the effectiveness of a simulation, as shown by Moorthy et al.[24] who included more experienced trainees. Similar-level surgical trainees may have different learning experience and variable skill improvement based on the level of familiarity and previous knowledge about VVs surgical procedures.

Almost all the studies considered technical skills improvement as the primary objective and major domain taught and assessed on the simulator. Other than the technical aspect of training, there are other soft skills that are required to ensure optimal performance of surgeons in training, like communication skills, ethical considerations, team dynamics, leadership, task delegation, professionalism, mutual respect, constructive feedback, crises management, realisation of limitations and ability to call for help. Moorthy et al. focussed on these variables.[24] Ideally, a simulator should be designed

in a way that beside addressing the surgical skill component, it should also be able to cater to the requirement of human-factor skills. Realistically though achieving this task has significant technical, financial and logistical challenges. A simulated OR, as used by Moorthy et al.,[24] with multiple simulators of varying fidelity specialised in addressing different skills can be a possible answer to this.

Assessment tools also varied among the studies. Majority of the studies used tools for assessment, most frequently OSATS and the Imperial College Evaluation of Procedural Skill (ICEPS), for the evaluation of the participants. GRS was used by most of the studies, which lacks the specificity of evaluating individual procedures.[30] Even though a few procedure-specific checklists and OSATS have been developed for VVs surgery, they are not yet validated. Combining GRS and procedure-specific checklists are usually considered to be more valid and reliable assessment tools to improve surgical skills.[31]

All the studies reported the use of simulation models to be an effective learning tool, but the generalisability of this effectiveness is still debatable. Reported skill improvement should be approached with caution because of non-validated tools being mostly used. The low number of participants with varied experience, different types of simulator models and assessment tools also limits the generalisability of simulator effectiveness.

One of the other limitations of the current review was the fact that most of the studies identified were not very recent, which points towards the need of having more focussed research on the topic. Despite relatively low number of old studies, the quality of the studies was found to be good as suggested by a good NIH score.

Conclusions

The utility of simulation in acquiring and enhancing surgical skills for VVs surgery were noted, but the absence of standardised simulation models, variability in participants' surgical experience and level of training along with the varied assessment strategies make the generalisability of the finding questionable. With the currently available literature, it is difficult to consider any particular type of simulator as a standard against which other simulators can be compared. All current simulators have their advantages and disadvantage, and, thus, development, advancement and validation of more simulators along with the predesigned curriculum are required for training surgeons for open VVs surgery. Similarly, validation of assessment strategies by the development of procedure specific checklists is also the need of the hour.

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NARRATIVE REVIEW

Innovations in surgery between the past and future: A narrative review of targeted literature

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Abstract

Innovation is the introduction of a new method or technology designed to change the way things are done. History is full of remarkable innovations in surgery over the years as surgeons have always been innovating and pioneering latest techniques and equipment that can benefit the mankind. Though persistent, progress has been far from uniform. Despite all the bells and whistles that these innovations bring to the table, the little acknowledged fact is that they are only accessible to a very small proportion of the global population. Five billion people on this planet do not even have access to an operating room when needed. It has been reported that conditions requiring surgery are responsible for one-third of all the deaths in the world. The current narrative review was planned to focus on the importance of innovations in surgery, to highlight the problems that were faced by resource-restricted countries in the past, and the necessity of innovative solutions to improve global surgical care in the future.

Keywords: Innovation, Surgery, Affordable, Cost, History.

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Introduction

Three-dimensional (3D) organs made by special printers, surgical simulators and stem cell delivery devices are some examples of research revolutions. A simple internet search will demonstrate the remarkable potential technology has to transform surgical care. Innovation is and has always been at the heart of surgery's core. Just as scientists and inventors have introduced telephones, air travel, space shuttles and robots, surgical innovations have proven to be equally revolutionary. Surgical care has come a long way and one must only take a glance at the past to be aware of the ground-breaking changes and developments that have taken place.

Throughout history, surgeons have always been innovating and pioneering latest techniques and equipment that can benefit the mankind. However, progress has been far from uniform. Despite all the bells and whistles that these innovations bring to the table, the little acknowledged fact is that they are only accessible to a very small proportion of the global population. Five billion people on the planet do not even have access to an operating room when needed. It has been reported that conditions requiring surgery are responsible for one-third of all the deaths in the world.[1-3] This is more than the numbers caused by the human immunodeficiency virus (HIV), tuberculosis (TB) and malaria combined.

The current narrative review of targeted literature was planned to focus on the importance of innovation in surgery, to highlight the problems that were faced by resource-restricted countries in the past, and the necessity of innovative solutions to improve global surgical care in future, especially in low- and middle-income countries (LMICs). Specialists in the field of Surgery, Epidemiology and Basic Sciences were involved to have a multidisciplinary view of the progress.

Results and Discussion

The demand for cost-effective inventions in surgery

The field of surgery has come a long way in the past few years, but, unfortunately, progress has not been uniform. Numerous advanced and sophisticated inventions are not available to most parts of the world owing to paucity of resources. Only 6% of all the surgical operations in the world are performed in the developing countries. As a result, the mortality rates for surgical conditions are extremely high in these countries.[3,4]

Lack of access to surgical care: Based on the Lancet Commission on Global Surgery report of 180 countries from all over the globe highlighting 98% of the inhabitants, it was found that there is a dire need of surgeons in Africa and rural areas which, on an average, had one surgeon serving over 2 million people.[5] One-third of the world's population cannot get optimum care owing to the lack of operation theatres. On the other hand, people of high-income countries (HICs) are rarely seen lacking access to surgical care.

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Accessibility and availability to surgery are vital issues in LICs, and can be further described by the three delays in pursuing, attaining and obtaining care.

Poor surgical outcomes: Even where surgical care is available, it is of poor quality. A lack of skilled surgeons in these countries results in severe concerns. The difference in mortality around surgery in the developing and the developed countries is 10% and 0.4%, respectively. In regions where there is no access to clean water and blood banks are scarce, the morbidity extent is more prominent.[6-9] Such high rate of postoperative complications leads to more frequent and longer hospital stays, making hospital beds unavailable to other patients. Early discharge is not a solution either as patients in LICs are not able to afford nursing care or physiotherapy at home even if such services are available in society.

Financial barriers to basic surgical care: Unlike the developed countries, which are covered by tax-funded health systems or health insurance schemes, all healthcare related expenses in developing countries are out of one's own pocket.

Additionally, there may be just one young breadwinner for the family and they cannot afford being hospitalised for a long time. Moreover, paid leave is a luxury which they do not often have. The women are the care-givers in such families, dragging their focus from their children and education.

Examples of low-cost surgical innovations: Low-income countries (LICs) need innovations that would work best in their environment. That can only be guaranteed when such technology is built specifically for that purpose. The goal is to provide a cost-effective idea which can work with limited resources without compromising on the quality of healthcare and for it to be of reasonable cost. Some of the best examples of low-cost innovations and their benefits have been widely acknowledged (Table).

Bogota bag: Developed in 1984 by Dr Oswaldo in Columbia, the Bogotá bag is one of the many low-cost innovations that emerged from a resource-restricted setting. It is a strong and flexible bag that is attached to the patient's abdominal wound temporarily before the abdomen could formally be closed. This bag costs $5 whereas other techniques with similar purpose cost around $153-$1,600. Studies have reported that it results in a lower incidence of complications compared to similar techniques.[10-12]

Mesh for hernia repair from propylene mosquito net: Dr Reddy and Dr Tongaonkar introduced the use of low-cost polypropylene mosquito net in herniorrhaphy.[13] An important clinical trial in Burkina Faso reported similar outcomes when compared to the more expensive meshes used in the West.[14] There has been no increase in septic complications, and it reduces the cost by two-thirds.[15,16] On occasions, it has even been considered better in terms of strength and anisotropy. Its cost is an estimated one-thousandth of the price of a commercial mesh.

Life box (LB) oximeter: Another groundbreaking innovation designed specifically for LICs is the Life box (LB) oximeter. Perioperative monitoring of patients using an oximeter is a basic requirement for care of surgical

Table: Examples of successful low-cost innovations in surgery.

Innovation	Description	Benefit
Bogotá Bag	A strong and flexible bag that attaches to the patient's abdominal wound temporarily before the abdomen could formally be closed.	This bag costs $5 whereas other techniques with similar purpose cost around $153-$1600. Studies have reported that it results in a lower incidence of complications when compared to much more expensive techniques.
Mosquito Net Mesh for Hernia Repair	Low- cost polypropylene mosquito nets for hernia surgeries	1000 times cheaper than traditional meshes but with similar outcomes when compared to its much more expensive counterparts.
Life-box Oximeter	A low-cost pulse oximeter that can be used in even the most resource restricted regions of the world without compromise on accuracy.	They cost around $250, compared with at least $1000 for a standard device used in HICs. Various studies have validated the positive effects and accuracy of LB oximeters.
The Chhabra Shunt	Low-cost alternative to shunt placement in patients suffering from hydrocephalus.	It is manufactured in India and can easily be purchased for $35 compared to the standard Codman-Hakim Micro Precision Valve shunt system which costs over $650. Many studies have been conducted comparing the two devices and it has been concluded that there is no significant difference in outcomes.
Arbutus surgical drill	A sterilized cover combined with a low-cost cordless drill with a similar torque and speed of a regular surgical drill	The cover can be changed on a regular basis and the complete unit costs 10 times less than a typical surgical drill.
Jaipur Foot	A prosthetic device that allows amputees to easily perform everyday tasks. The design also allows amputees to squat, sit cross-legged and even trek on rugged terrain.	Readily available using locally sourced materials for as low as 3 USD.

LB: Life-box, HICs: High-income countries, USD: United States dollar.

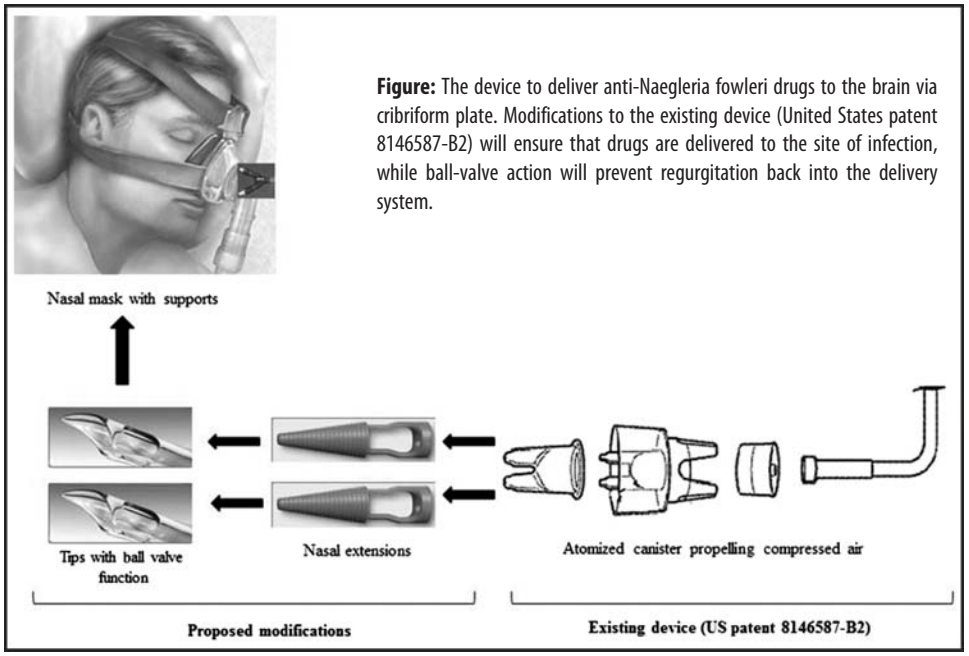

Figure: The device to deliver anti-Naegleria fowleri drugs to the brain via cribriform plate. Modifications to the existing device (United States patent 8146587-B2) will ensure that drugs are delivered to the site of infection, while ball-valve action will prevent regurgitation back into the delivery system.

patients in the developed world.[17] It comes as no surprise that in sub-Saharan Africa, 70% of operating theatres do not have oximeters.[18] Using pulse-oximeters, along with the WHO Surgical Safety Checklist, has the potential to make surgical operations 50% safer.[19]

Various studies have validated the positive effects and accuracy of LB oximeters.[20] These devices have proven to be an inexpensive and excellent alternative that the developing countries can adopt without compromising much on quality. It is being reported that even cheaper versions are on their way to the markets soon.

Chhabra shunt: The Chhabra shunt is a low-cost alternative to shunt placement in patients suffering from hydrocephalus. It is India-made and can be available in $35 compared to the standard Codman-Hakim Micro Precision Valve shunt system priced over $650.

Many studies have been conducted comparing the two devices, and it has been concluded that there is no significant difference in outcomes.[21,22] Furthermore, Kabachelor et al. also compared the Chhabra shunt to the Bactiseal universal shunt and found no difference in rates of shunt complications, and death.[23]

Arbutus surgical drill: A typical surgical drill costs around $30,000. In addition, it needs to be sterilised regularly to prevent postoperative complications. However, Arbutus has recently introduced a cover which can be sterilised repeatedly and, when combined with a low-cost cordless drill of similar speed and torque, costs one-tenth of the price of a regular surgical drill.[24]

Transcribrial route device: Using simple concepts to resolve big problems have invented many devices and instruments that could prove to be of translational significance. One such example is the transcribrial device, which was developed at the Aga Khan University, Karachi, to overcome the blood-brain barrier to deliver drugs to the brain in meningoencephalitis, and stem cells to the brain in neurodegenerative diseases.[25] This device (Figure) is suited to deliver the drugs in Naegleria fowleri-induced encephalitis with nasal components and device details to deliver the drugs.[26] Also, the modified device has been proposed to be used to accelerate stem cell delivery to the brain in Alzheimer's disease.[27]

Jaipur foot: The Jaipur foot has been regarded as one of the best innovations of the 20th century. Developed by orthopaedic surgeon Professor P.K. Sethi, it allows amputees to easily perform movements in almost all directions, including dorsi-flexion, plantar-flexion, inversion and eversion.[28-30] The design also allows amputees to squat, sit cross-legged and even trek on rugged terrain. Due to its immense popularity in LMICs in Africa and Asia, it is made using local materials and is readily available for as low as $3.

The strength of the current narrative review is the involvement of specialists in the field of Surgery, Epidemiology and Basic Sciences who went over a large data set to have a multidisciplinary view of the innovations. However, the current study was not a systematic review of all relevant papers, which is a limitation. There should be future studies reporting the cost-effectiveness of various low-cost innovations.

Conclusion

Technology in the medical field has advanced over the last century. Cost-effective alternatives are mandatory for safe surgical practices in the developing world and are critical for a better change or advancement in the developed world as well.

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NARRATIVE REVIEW

Understanding deep learning — challenges and prospects

Niha Adnan, Fahad Umer

Abstract

The developments in Artificial Intelligence have been on the rise since its advent. The advancements in this field have been the innovative research area across a wide range of industries, making its incorporation in dentistry inevitable. Artificial Intelligence techniques are making serious progress in the diagnostic and treatment planning aspects of dental clinical practice. This will ultimately help in the elimination of subjectivity and human error that are often part of radiographic interpretations, and will improve the overall efficiency of the process. The various types of Artificial Intelligence algorithms that exist today make the understanding of their application quite complex. The current narrative review was planned to make comprehension of Artificial Intelligence algorithms relatively straightforward. The focus was planned to be kept on the current developments and prospects of Artificial Intelligence in dentistry, especially Deep Learning and Convolutional Neural Networks in diagnostic imaging. The narrative review may facilitate the interpretation of seemingly perplexing research published widely in dental journals.

Keywords: Artificial Intelligence, Deep learning, Machine learning, Dentistry, Imaging, Neural networks, Convolutional neural network, Intraoral radiography, Object detection, Semantic segmentation, Instance segmentation, Big data.

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Introduction

Artificial Intelligence (AI) deals with the science of simulating human behaviour in machines.[1] The exponential development in technology over the past few decades has led to the evolution of AI, making it an innovative research area across a wide array of industries.[2] The two subsets of AI are Machine Learning (ML) and Deep Learning (DL) (Figure-1).[3] ML is a subdomain of AI, and DL is a further subdivision of ML. These techniques can be used to develop AI architectures and subsequently trained on an abundant set of existing data.[4] The consequence is an architecture capable of making accurate predictions on new, unseen data.[4] Both techniques are widely used today, revolutionising the AI industry.

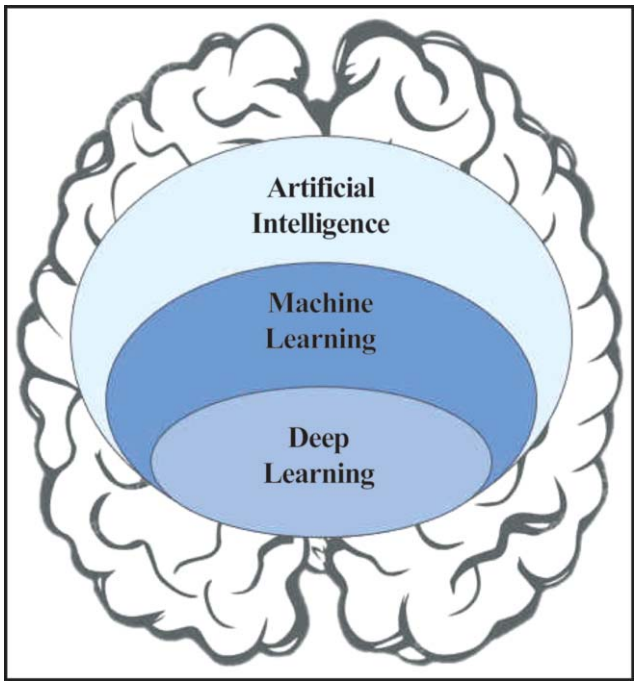

Figure-1: Subsets of Artificial Intelligence (AI).

AI originated as a single-layered neural network called 'Perceptron', laying the groundwork for the progression of DL techniques.[5] However, it could not experience the growth that was anticipated due to challenging technological barriers that existed at the time of its incipience.[6] These included a lack of computing power and the unavailability of extensive annotated datasets for training these architectures.[6]

The work in this field continued to some extent under different aliases until 2006 when AI experienced a paradigm shift, giving precedence to 'big data' in developing AI architectures.[7] This was after the ImageNet database worked for the advancement of computer vision techniques.[7,8] ImageNet is a collection of over a million annotated images accumulated from the internet and has been leveraged into training various algorithms since its commencement.[7,8] This instigated a rampant growth that both ML and DL experienced for the first time since their inception.[3]

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The very premise of AI is to learn from the data that it collects; the more data that is collected and analysed, the more accurate the algorithm becomes at making predictions.[9] Big data has been the driver for AI advancements, but no amount of data will ever replace human intuition.

A detailed discussion on ML can be found in literature.[3] The current narrative review planned to keep its focus on DL techniques.

Deep Learning techniques

DL comprises multi-layered artificial neural networks (ANNs), modelled after the rudimentary picture of a human brain. The basic structure of an ANN consists of an input layer, one or more hidden layer(s) and an output layer, with each layer composed of nodes, also known as artificial neurons (Figure-2).[5] The 'deeper' the DL algorithm, the more hidden layers it contains, allowing for more 'features' to be extracted from a given dataset. Every layer is highly interconnected with the others; and the passing of data from one layer to the next is a process converting the output of one layer into input for the next.[5] The algorithm learns the 'maps' between the given inputs and outputs and with sufficient training, it is able to apply those learned patterns on unseen input data to derive accurate output predictions.[1]

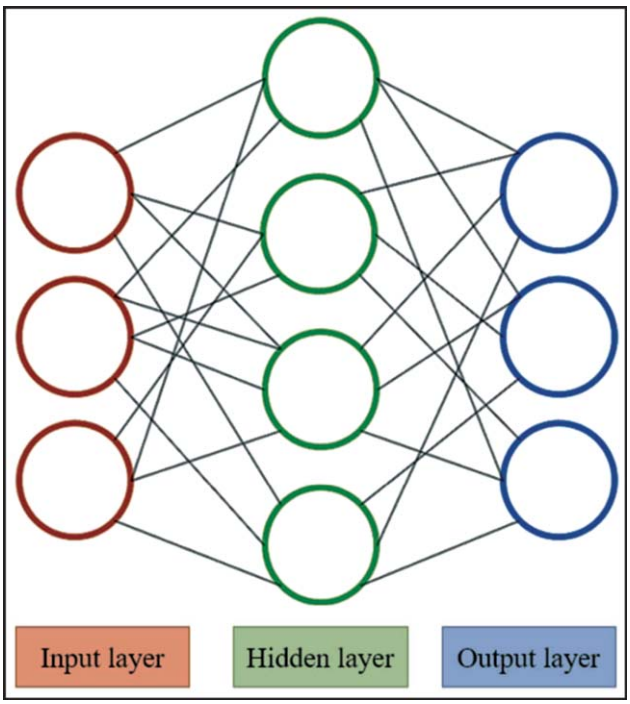

Figure-2: The basic structure of artificial neural networks (ANNs).

Table: Terminologies and definitions.

Terminologies	Definitions
Computer Vision	A field in computer science enabling the simulation of the human visual cortex in machines.[9]
Feature	Variables that are relevant to the training of an algorithm.[9]
Dataset	It is a set of data, for example images, that contain important features for training an algorithm.[9]
Annotation	Labelling the relevant features in a machine-learnable format.[9]
Epoch	Each complete cycle of running the dataset through an algorithm.[9]
Iteration	The number of batches required to complete one 'epoch'.[9]
Feature Extraction	A pre-processing step that reduces data into more manageable variables for the algorithm to learn.[9]
Ground Truth	The ideal expected output determined by the subject specialist/ annotator.[9]

DL algorithms can process large amounts of data and its performance improves as it analyses more data.[9] The 'feature extraction' (Table) step is already incorporated into DL algorithms, eliminating the need for manually determining relevant features for it to extract and learn, which is a prerequisite for ML techniques.[9] After an appropriate level of training, the DL algorithm can extract hidden features autonomously with little to no explicit programming.[9]

Training a DL algorithm

The process of developing an AI algorithm involves three basic steps: training, validating and testing (Figure-3). Training and validation employ the same annotated dataset, whereas testing is conducted on a different, unseen, annotated dataset.[9] By running the training data through an algorithm, it is trained to produce a particular prediction with each epoch. Usually, the data is fed through it in iterations. These iterations are run through the algorithm in distinct patterns, allowing it to learn every possible aspect of the 'features' embodied in the training dataset.[9] This leads to better 'generalisation' of the important features contained within the dataset, enabling its applicability on a wide range of unseen data in the future.[9] With each epoch, the parameters and hyperparameters of the algorithm are adjusted to ensure greater accuracy of the predictions. A parameter is a variable that is internal to the algorithm and the value is determined by the algorithm itself.[9] Whereas a hyperparameter is a value external to the algorithm set manually by the data scientist operating it, and can be tuned manually to further increase accuracy.[9] After the efficacy of the algorithm has been validated on the same dataset, testing data is run through it.[9] The results make the adequacy of training evident via the accuracy of predictions made by the algorithm.[9] This process can be repeated and the performance can be improved

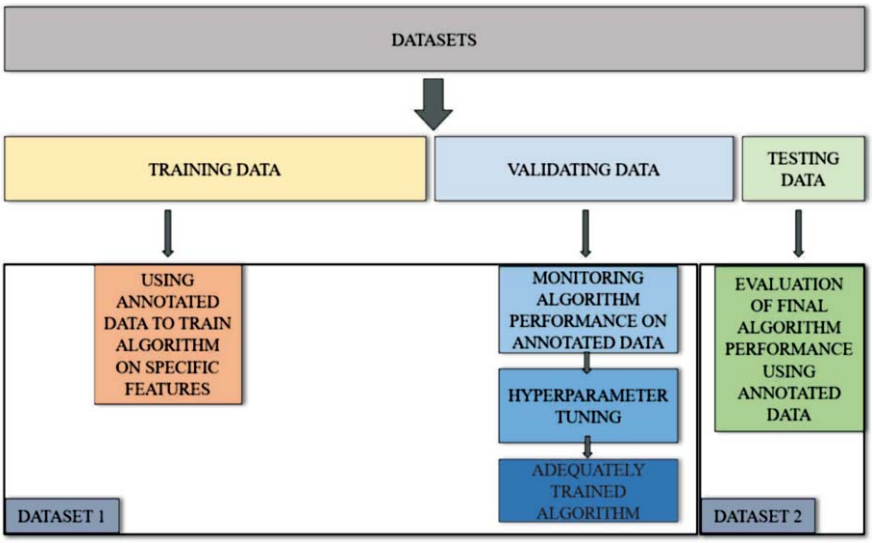

Figure-3: The three basic steps of developing an Artificial Intelligence (AI) algorithm.

further by running more annotated training data until the desired accuracy level is achieved.

Convolutional Neural Network (CNN)

The most established algorithm among DL architectures is the Convolutional Neural Network (CNN).[2] It has been in use predominantly for computer vision tasks. CNNs explicitly process data with complex patterns, such as images, with the goal to mimic functions of the human visual cortex.[2,10] 'Image processing' is the specific feature extraction task performed by these neural networks. This is executed by the special convolutional layer that is incorporated into an otherwise traditional DL algorithm (Figure-4).[2,10] The role of CNNs is to reduce the image according to pixels, making the image easier to process without losing important features.[2] Hence, these neural networks can make accurate predictions whilst simultaneously allowing for a reduction in the computational power required to effectuate these tasks.[9] These are being trained widely to be applied on radiographic images in the fields of medicine and dentistry.[1]

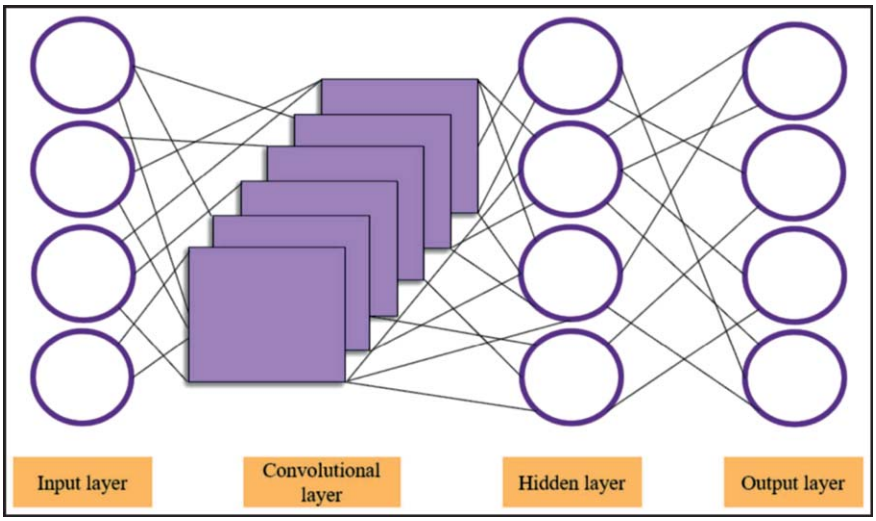

Figure-4: Layers of a Deep Learning (DL) algorithm.

Evaluating performance of DL algorithms

Different metrics are utilised in DL to discern the performance of algorithms assessed against the ground truth determined by subject specialists/ annotators in the 'testing' dataset.[1] The application of various metrics is imperative to ensure the optimal quality of the algorithm.[1]

These performance metrics are run on the testing dataset, giving true positives and negatives, as well as false positives (FP) and false negatives (FN) of the predictions generated by the architecture.[1] The values are consequently used to determine the precision, accuracy, recall/sensitivity, and F1-score of the trained algorithms measuring their true capabilities.[11] Other metrics include the receiver operating curve (ROC), area under the curve (AUC) and dice index to evaluate the performance of architectures.[1,11] The pertinent selection of relevant metrics for evaluation of the various AI architectures is a crucial task. It is dependent upon the specific task being carried out by the algorithm as well the aspect of its training that requires evaluation. For example, F1 score is used to determine the robustness of an algorithm.[1] This aspect of algorithm training requires the proficiency of data scientists[11] and a thorough discussion on this aspect of algorithm training is far beyond the scope of the current paper.

CNNs in dentistry

The evolution of AI in medicine and dentistry have been evident in the studies published in the past few years.[1] AI has mostly been involved in the diagnostic aspects of these fields, approaching the level of expertise of the clinicians.[10]

In dentistry, CNNs can detect and segment anatomical structures and

pathological conditions on radiographic images.[1] This makes it relatively easy for clinicians to distinguish the positions and characteristics of teeth and any associated pathology as part of their preliminary clinical examination.[2] In general, CNNs have performed well in recognising and classifying teeth on both two-dimensional (2D) and 3D radiographs.[1] They are being studied as adjuncts in the identification of dental pathology, including caries, periapical lesions, periodontal bone loss, vertical root fractures, osteoporosis, cancers of the head and neck region, as well as for working length determination in endodontics, etc.[6,12-18]

Theoretically, adequately-trained CNN architectures can perform as well as clinicians, with the potential to surpass the level of their performance and diagnostic abilities. The aim is to simplify the provision of dental care, make it cost-effective, and concurrently eliminate human error in diagnoses and treatment plans devised by clinicians.[2]

Tasks performed by CNNs

The various computer vision tasks performed by CNNs include Object Classification and Localisation which entailes assigning labels to a single object in an image and localising their positions via a bounding box (Figure-5A); Object Detection which includes assigning labels to every object in an image belonging to a particular group via bounding boxes (Figure-5B); Semantic Segmentation in which individual pixels are labelled into groups via fluid margins (Figure-5C); and Instance Segmentation which employs Object Detection as well as Semantic Segmentation, labelling each pixel in every group via fluid margins (Figure-5D).[9]

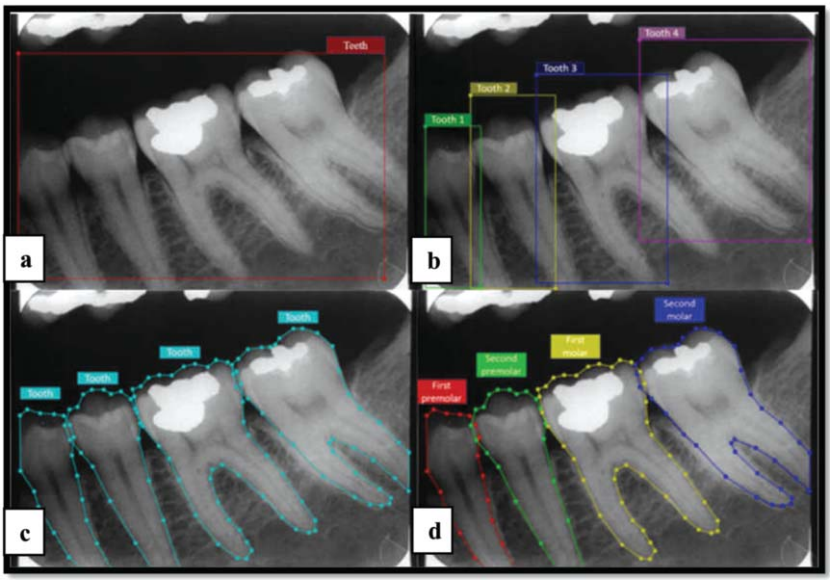

Figure-5: Various computer vision tasks performed by Convolutional Neural Networks (CNNs) include (a) Object Classification and Localisation, (b) Object Detection, (c) Semantic Segmentation, and (d) Instance Segmentation.

Challenges and Prospects

The applications of AI in dentistry is lagging behind by a few years compared to that of medicine.[12] This is largely due to the cost of acquisition and annotation of big data required for sufficient training of AI algorithms, which is needed to ensure robustness of the architecture.[12]

The ability of the algorithm to make predictions is where the 'generalisability' of an algorithm is important to consider.[1] The key to improving the generalisability of an algorithm is determined by the extensiveness of the dataset used to train the model.[3] 'Overfitting' of data is one of the main challenges in the applicability of AI, as an overfitted algorithm is not generalisable on unseen data.[19] A method to reduce overfitting is via data augmentation, which includes flipping, translation, cropping, rotating and applying filters on the existing images in a dataset.[8] This ensures the training of the algorithm on every possible presentation of the training data.[8]

An abundance of labelled data is desirable but rarely available in medical and dental imaging, and, hence, another method called 'transfer learning' can be applied.[20] Transfer learning is a technique where a neural network that is pre-trained to predict a 'general feature', like a car, in an image is then utilised on a different dataset with seemingly incompatible features, like a tooth, for the architecture to recognise after minimal preliminary training on the relevant features.[20] The exact mechanism of this 'smart behaviour' remains unknown, giving rise to the 'black-box effect' where the exact workings that allow DL architectures to map input to output remain unclear.[19] Employing this technique, however, significantly reduces training time and computational resources while producing quality architectures.[20]

The lack of open-access, standardised and annotated datasets to train AI algorithms is the main impediment in the exponential growth of AI in dentistry.[12] The annotation of medical images adds to the cost of time as well as the cost of subject specialists needed for accurate annotation of datasets. The provision of standard quality datasets for training algorithms will allow for their consistent clinical implementation. The limitations of computing power has largely been

overcome, but can be improved further by incorporating quantum computation which is exponentially faster and makes it a valuable platform that should be explored to cause further advancement in AI.[12]

There is a need for better understanding of the processes involved in the AI as well as overcoming its vulnerabilities to allow for its applicability in crucial, patient-related diagnostic problems.[12] The ultimate goal is to train a machine to think like humans and perform tasks with more accuracy and greater speed, lowering resource utilisation in the long run.

Conclusion

AI has several potential applications in the fields of medicine and dentistry and there is a need for clinicians to be cognizant of all the past and current advancements. Being aware of the key concepts, workings, strengths as well as limitations of AI in clinical practice is crucial for clinicians to work towards further improving diagnoses and patient care.

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NARRATIVE REVIEW

Surgeons and ethical challenges in operating room

Syed Muhammad Nazim, Syed Shahabuddin

Abstract

Ethics lie in the heart of professionalism. In surgery, it represents an essential element, with surgeons facing ethical challenges in their routine practice. The rapid expansion of surgical technology and innovation along with the use of resources and consideration of conflict of interest have brought up the need for the development of current surgical code of ethics. Operating room represents a stressful environment where patients' lives depend upon careful preparation, planning and execution. The progression of surgery within the operating room must be done in harmony and in line with the ethical principles of autonomy, beneficence, non-maleficence and justice. Discussion of ethical problems arising in the operating room is not a common subject in surgical literature. The current narrative review was planned to cover ethical concerns related to patients' safety and privacy in the operating room and some of the evolving topics, like ethics of overlapping surgery, live surgical broadcast and 'do not resuscitate' policy in the operating room.

Keywords: Surgical ethics, Operating room, Overlapping surgery, Live surgery broadcast, Safety, Privacy.

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Introduction

Surgeon-patient relationship forms the core of surgical ethics. Operating room (OR) represents a stressful environment where patients' lives depend upon careful preparation, planning and execution.[1] The progression of surgery within OR must be done in harmony with others involved in the care of patients. Since medical ethics, in general, and OR ethics, in particular, are not taught to the trainees and surgeons, this deficiency is reflected in their clinical practice throughout their professional career. The current narrative review was planned to highlight the ethical problems arising in the OR, and their solutions in the light of literature and guidelines. The review was done by the Urology and Cardiothoracic Surgery section at the Aga Khan University Hospital (AKUH), Karachi, and comprised literature published between January 2007 and June 2021 that was searched on electronic databases PubMed, Science Direct, Google Scholar and Embase. Only English-language full-text articles were selected for the review.

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Patient's privacy in OR

Patients undergoing surgery are quite apprehensive about their dignity and fear of compromised privacy. Privacy is considered to be a complex concept having multiple elements that are difficult to break down.[2] It is generally defined as having a control of oneself with full autonomy. An anaesthetised patient is extremely vulnerable. It is, therefore, particularly important for the OR personnel, including surgeons, nurses, anaesthetists etc., to safeguard a patient's autonomy and display patient's rights on OR premises to ensure that the patient's dignity and privacy is being maintained, protected and promoted.[3] This also requires attention to the environment and professional attitude, as everyone should feel responsible to challenge the abusive and disrespectful attitude towards the patient, and activities and actions of a colleague that may compromise a patient's privacy.[4]

Further insight into the patients' rights to autonomy will lead to questioning the presence of observers or spectators whether they are part of medical team for education and training or industrial representatives providing technical assistance. This can potentially lead to a breach of patient's confidential information, but this may be resolved by way of informed consent beforehand.[5] Video recording of a surgical procedure, although another source of teaching, training and review, has the potential to compromise a patient's privacy.[6] Similarly, the exploded usage of closed social media group (CSMG) in real time by sharing posts in the form of comments and videos to improve surgical education and achieve desirable outcome is another potential source of compromising confidentiality. However, beneficial usage of CSMG done with constructive intent to share de-identified data is supported by certain medical societies with emphasis on following regulations to comply with the Health Insurance Probability and Accountability Act (HIPAA) and seeking informed consent wherever deemed necessary by the surgeon.[2]

Patient's safety in OR

Safety of the patients is another major aspect of surgical

practice. Operating room is a place where healthcare providers from different disciplines may face confrontation, and it is important to display professionalism and show respect towards colleagues to facilitate achieving best quality care with the highest level of safety.[3] The surgical team has tremendous pressure to carry out the procedure as planned and the anaesthesiologist remains busy providing acute care which in itself is a crucial task. Their performance depends on effective team-work and an uninterrupted environment, as interruptions have the potential of being risk factors for errors.[7] Patient-OR interaction is a unique phase of healthcare where the patient is defenceless and exposed to potential harms by improper equipment, instruments, medicines, lights, temperature and staff along with poor decision-making. Similarly, desirable surgical outcomes require a safe and conducive environment free of disruption, interruption and distraction (DID) to enhance concentration towards the completion of a procedure with safety. It is evident that adverse events due to unavoidable human errors result from flaws in the system and inadequacies in organisational frameworks.[8]

In a systemic review, McMullan et al.[7] examined the relationship of DIDs with operative duration, team performance, individual performance and patient safety outcomes in terms of surgical-site infections (SSIs), and found that DIDs were associated with negative outcomes. Similarly, Cohen et al.[8] indicated that the infiltration of personal electronic devices disengage the attention from the primary task, compromising the safety and increasing the margin of error.

It is imperative to have processes in place like intraoperative checklist by the World Health Organisation (WHO) and surgical timeout to ensure closed loop communication and to promote safety with reduction of adverse surgical outcomes.[9,10] Strong professional commitment, team-work and effective implementation of these checklists will help achieve improved safety.

Concurrent and overlapping surgeries:

The terms overlapping surgery (OS) and concurrent surgery (CS) are used to describe the involvement of a single surgeon for two or more surgical procedures simultaneously. Also used interchangeably, these terminologies refer to different practices. In contrast to a sequential start case, where overlap of exposure in one case occurs with the closure of another case, in OS, the primary surgeon responsible for operating two or more patients is present for all critical and key portions, while in CS, he is not available for those portions of surgical procedures.[11]

In multidisciplinary procedures, OS is common with one specialty surgeon present only for a specified portion requiring a particular surgical expertise, such as a urologist providing flank/retroperitoneal exposure to a spine surgeon operating on the lumbar spine later.

Across the globe, healthcare has become a complicated industry driven by corporate culture with multiple stakeholders, such as healthcare institutions, doctors, insurance companies and others. In this culture, efficiency is measured by numbers; the number of patients served and operated, with less focus on good clinical outcomes and quality. The practice of OS and CS was established to improve this efficiency.[12]

Literature evidence for overlapping surgery: In the past few years, there has been a surge in literature regarding CS and OS, with the areas of focus being the difference in various outcomes like safety of the procedure, healthcare cost, impact on residents' training and perioperative data.[13]

Data regarding comparison of serial cases versus OS has shown that OS is a safe practice and does not lead to significant differences in patient outcomes.[13,14] Theriault et al.[13] analysed 18 published studies incorporating more than 1.2 million surgical cases out of which ~5% were OS cases. Parameters such as procedure time, reoperation rates, length of hospital stay and re-admission rates were not significantly different between serial and OS cases. Kent at al.[14] surveyed the perceptions of 1454 patients regarding OS and found that only 4% patients were aware of the practice, and 69% expressed opposition to it.

The hype regarding overlapping/simultaneous surgery was created after the publication of an article in October 2015 in the Boston Globe[15] describing a case where a patient became quadriplegic at the Massachusetts General Hospital (MGH) following a spine surgery performed by a surgeon who was involved in another complex surgical procedure at the same time. The case was investigated and the jury found that the surgeon had failed to inform the patient about his plans to operate on more than one patient at a time. This case generated a strong emotional debate, and patient right advocates questioned hospitals' practices and raised concerns about CS.

Issues and ethical concerns with overlapping surgery: There are ethical concerns both in favour of and against OS practices. OS/CS permits efficiency by maximising the OR space utilisation, decreasing waiting times and lowering the hospital vacancy with increased patients' access to specialised surgical care. It also provides autonomy to residents and fellows by facilitating them to perform non-

critical surgical operations.[13,16] It can be less efficient for the anaesthesia team and could expose patients to prolonged time of anaesthesia.[11] Running simultaneous ORs have potential risks, such as exposure of patients to potential complications and poor outcomes due to unsupervised surgery indicating failure on the surgeons' part to adequately train the residents.[17] The motivation behind OS and CS might be due to a desire to maximise revenue and potential billing fraud by a surgeon.

OS can have substantial professional, ethical and legal concerns. The ethical aspects include what is the critical portion of a particular case and who defines it, who is a qualified practitioner, and what are the special situations where a surgeon should obtain informed consent for OS.[12,17]

As modern surgery is team-work, the American College of Surgeons (ACS) and other organisations have laid down evidence-based and consensus review processes and have formulated guidelines. These guidelines have emphasised that OS is appropriate and is unlikely to have negative effect on patients' safety, but CS/simultaneous surgeries should not be conducted.[12] The fundamental difference between OS and CS is the key/critical portion of the surgery which the ACS has defined as "stage(s) or part of the procedure associated with complexity or risk, where essential technical expertise and surgical judgments are necessary to achieve the optimal patient outcome".[12]

The ACS has mentioned that although the primary attending surgeon is responsible for the case, the professional may delegate part of an operation to qualified practitioners, such as follows, residents, surgeon assistants, anaesthesiologists, nurses or another attending under his/her direction.

Corrective actions: Healthcare organisations should review and update their policies about OS and CS with due assurance of compliance with these policies. System-specific guidelines for OS and CS should be formed by multidisciplinary committees with the involvement of administrators, patient safety experts and OR personnel, and these policies should be made with specific areas of focus, like defining the 'critical/key portion' of every indexed surgical procedure, and who should be allowed to perform non-critical components without supervision.[17] This also includes documenting the surgeon's OR entry and exit times. In the United States, the Centre for Medicare and Medicaid Services (CMS) billing policy states that a teaching surgeon can bill for OS only if the professional was present during the 'critical portion' of procedure and was 'immediately available' during the entire procedure or arranged for another qualified surgeon.[18]

Theriault et al.[13] devised the term Mandatory Attending Portion (MAP), defined as the minimum portion of a surgery that the attending surgeon needs to be physically present for. This is the most technically challenging and demanding portion of a surgical procedure. The governing principal is that it should not go simultaneously with MAP of another procedure. Another area that needs pre-defined MAP in OS is multidisciplinary surgery with the involvement of two or more surgeons from different specialties in one case, such as inferior vena cava (IVC) tumour thrombectomy by a vascular surgeon in a complex radical nephrectomy case performed by a

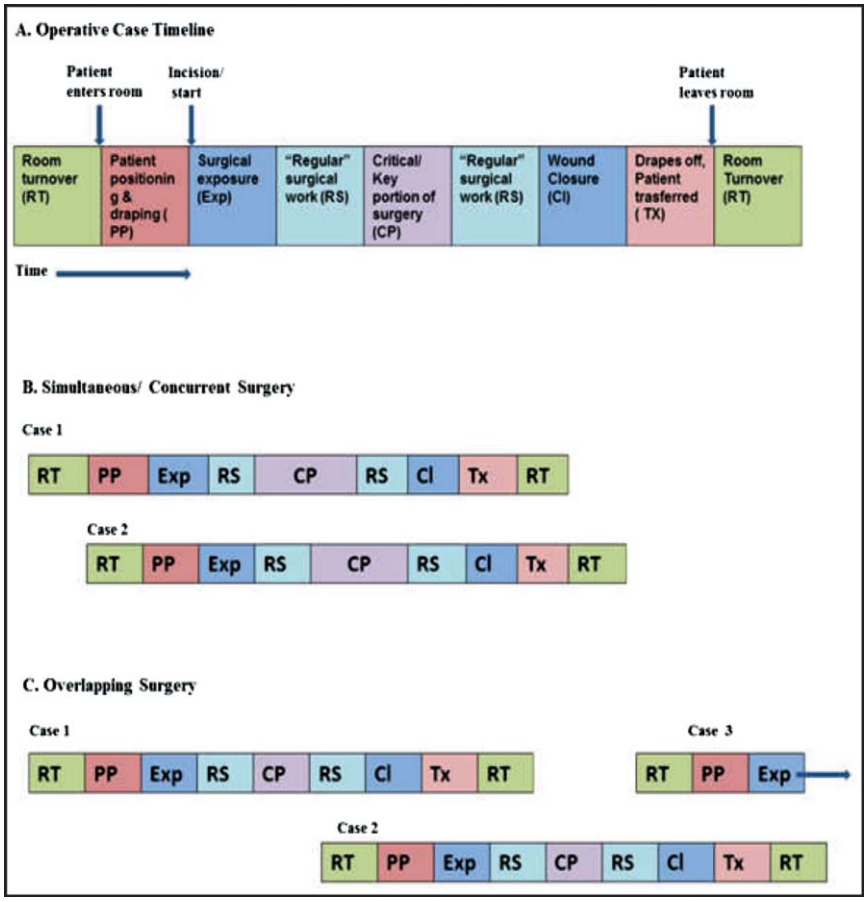

Figure: Conceptual layout of surgical case-flow in the operating room: A) Timeline of an operative case. B) Simultaneous/Concurrent Surgery. C) Overlapping surgery.

urologist where each specialty's MAP should be pre-defined[13] (Figure).

Ethical principles governing overlapping surgery and concurrent surgery: These involve elements like autonomy and informed consent, beneficence, non-maleficence and Justice.

Autonomy and informed consent: The trusting relationship between the surgeon and patient and/or his family gives them the assumption that the primary surgeon will perform the entire operation. Patients should be given the understanding of OS possibility, so they would not only have fewer concerns with OS, but also have the option of deciding to seek care from another surgeon or at a later time.[12,17]

Beneficence: This principle requires the surgeons to assure that their actions are consistent with patients' values, needs and agreed-upon treatment. The primary surgeon should be capable of maintaining focus on each patient's surgery in case of OS.

Non-maleficence: It stipulates that the surgeon's actions/or failure to act do not harm the patient. The surgeons should be available for critical/MAP portions and should have a sound knowledge of their team members' skills and maturity to do an unsupervised surgery.

Justice: This principal requires that the surgeons treat all patients irrespective of their religions, cast, gender, cultural background and ability to pay.

Live surgery broadcast (LSB)

Surgeons who are also part of the academia have the responsibility to transfer their skills, knowledge and experience to others. With the technological advancement, live surgery is no longer limited to the people in the same OR.[19] Since the first live surgical broadcast (LSB) in 1996 demonstrating laparoscopic cholecystectomy during a surgical conference, it has now become a growing trend in international surgical meetings.[19] In LSBs, an experienced surgeon demonstrates his/her techniques to the audience comprising students, colleagues and peers. This activity helps to improve intervention, and generate discussion with the aim of knowledge dissemination and ultimately improving the patient's outcome. With the fast-paced advancement of telecommunication system and audio-visual (AV) technologies along with the implementation of intrinsic video-optic elements of endoscopic, laparoscopic and robotic systems, high-quality images are relayed in real time to remote sites.[19-21] Thus LSBs, particularly for minimally invasive procedures, have increased exponentially.[21]

Merits of live surgery: LSB helps to improve the collective knowledge of many observers during a conference and, hence, constitutes a form of research in a way that a new technique/skill is being disseminated and could contribute to generalisable knowledge.[20] Its benefits include training of less experienced surgeons; real-time interaction of audience with the panel of experts to learn various surgical options and improvement in decision-making; and observation of expert skills during challenging and complex cases performed using modern devices and equipment.[22]

The performing surgeons stand to benefit in terms of gaining knowledge and professional experience, and the ability to develop creative solutions to problems during a procedure. It can also improve surgical education, especially for niches like endovascular surgery and paediatric urology, where small case load is a training limitation.[23]

Brunckhorst et al.[22] in a systematic review studied LSBs and their safety and impact on training. They found that LSBs fulfilled the educational value criteria, such as feasibility, acceptability, construct and concurrent validity. Another recent systematic review by Carbonara et al.[19] identified 46 studies from 6 specialties, including urology, interventional cardiology, gastrointestinal (GI) endoscopy, GI surgery, ear-nose-throat (ENT) and ophthalmology. They assessed the patient outcome reporting, current use of LSBs, development of LSB, and educational value. They found that almost all the studies did not show a higher risk of complication or worse outcome.

Ethical concerns and disadvantages of live surgery: Despite it's educational benefits and popularity, many concerns have been raised regarding LSBs.[21,24] There is an increased risk to patients during LSBs due to frequent interruptions and the risk of infection from both broadcast crew and unnecessary equipment. There is violation of medical secrecy as patients' dignity and privacy are compromised and their identification and confidential record may be revealed to the audience.[20,24] Many a time, the patients do not even know about who is going to perform the surgery and whether the procedure will be filmed or broadcast. They can be put on standby/prolonged anaesthesia mode before smoother broadcasting starts. They are at the risk of possible cancellations and scheduling of procedure to fit within the time limits of the meeting.[20]

Many factors can affect a surgeon's performance during a live surgery. Surgeons travelling to perform a live surgery in a conference can experience travel-related fatigue, jetlag, unfamiliar working environment or sub-optimal operating conditions that may adversely affect their technical and judgment abilities.[25] Working in an environment with communication/language barrier might increase the anxiety and can affect patient outcome.[24] Unfamiliar equipment and devices provided by sponsoring and marketing companies for promotion during LSBs could also lead to potential hazards for patients. Undue noise and distraction could compromise a surgeon's concentration, vision and could impair professional dexterity.[24] Surgeons have undue psychological stress due to scrutiny by the panel and the audience, and by the obligation to answer questions during the procedure. The visiting surgeon is often not aware of subsequent patient outcome or any complications that may arise in due course.[23]

Regulations and recommendations for LSBs: Following the death of a patient undergoing aortic aneurysm repair during an LSB in Japan, a number of institutions and associations have revised their policies and have evaluated their practices.[26] The Royal College of Surgeons in the United Kingdom made specific recommendations about LSBs during its meetings, with special emphasis on patient safety.[27] Many societies have proposed good practice guidelines for LSBs. The European Association of Urology (EAU) LSB guidelines recommend that live surgery should be performed under a strict code of conduct, with transparency regarding all the steps of the event and its outcomes. The central theme should be "the right surgeon, the right patient, the right environment and the right intentions".[28]

Brunckhorst et al.[22] and Carbonara et al.[19] in their systematic reviews identified 13 guidelines and policy statements by major surgical societies[28,29] and the Royal College of Surgeons[27] (Table).

Solutions to potential problems of LSBs: The core ethical principles of the Belmont report, i.e. respect for persons, beneficence, justice and, especially, principles of patient's autonomy and safety, must be applied.

LSB should not be regarded as clinical practice, but rather a form of clinical research and, hence, must be subjected to institutional review board (IRB) approval, including conduct under a written protocol with clear objectives and procedures designed to reach those objectives.[27,28]

A senior surgeon should be assigned as "patient's advocate" who needs to be present in the OR, could speak for patient's right and should have no conflict of interest. The 'advocate' should be able to stop unnecessary delays and terminate the link in case of any complications or even the entire surgery if it is felt that the patient's best interest is compromised.[20]

The performing surgeon should take active part in case-selection and decision and discussion with the patient, the family and the host team, and must familiarise with equipment, environment and personnel beforehand.[17]

Ethical principles governing LSBs: These include four critical elements. The first of which is respect of patient's autonomy. An open and honest communication should be done with the patient and the family. Specific informed consent for broadcast should be obtained with complete explanation of potential risks. The extent of transmission should be to a limited and registered audience only.[24]

The second element is beneficence. The surgeons should consider patients' wellbeing rather than their own conflict of interest, such as financial gains, access to sponsorships

Table: Common elements reported in live surgery guidelines.

Domain	Remarks
General	• Live procedure demonstrations should not be used for marketing or commercial opportunities for the physician, host institution or equipment used in the procedure
	• The educational value must exceed a pre-recorded operation
Patient	• Patient safety comes first and the surgeon must be willing to terminate the live broadcast if this becomes compromised
	• The patient's privacy must be preserved at all times
	• Patient should sign a separate consent for live surgery broadcast
Surgeon and Surgical team	• Live broadcasts should be performed at a surgeon's home institution where possible
	• A moderator between the audience and surgeon should be used to prevent questions distracting the surgeon at key steps
	• Surgeon must be willing to terminate the live surgery broadcast as needed
	• Surgeons should consider performing only procedures with sufficient experience and expertise
	• Surgeons should strongly consider bringing their own team and equipment while performing live surgery in another (host) hospital
	• Non-essential people must not be present in the OR at the time of surgery
	• Surgeons should not participate in the broadcast where non flexible schedules limit the duration of procedure

and advancement of their own careers and reputations.

The third element is non-maleficence. The patient might face additional delays in receiving the treatment due to a particular date of LSB and, thus, there can be delays in treatment. During the event there can be intraoperative delays and standby anaesthesia which can be potentially hazardous for the patient.

The final element comprises justice, fairness and equality which decides who will receive the indicated treatment by an expert and who will not.

Alternatives to LSBs: An alternative educational tool to LSB is a semi-LSB which is a pre-recorded video of a surgical procedure with minimal editing. It can be advantageous as videos can be paused or played back, and the audience can ask questions to the panel of surgeons while eliminating the ethical problems pertaining to the patients, such as safety and privacy, and those pertaining to the surgeons, such as anxiety and distractions, and other issues mentioned above.[21]

In a systematic review by Carbonara et al.[19] the perceptions of surgeons performing the LSB or semi-LSB were evaluated. Both modalities were perceived to be equally valuable, but 38% felt that the complication rate was higher with LSB.

'Do Not Resuscitate' (DNR) code in OR

These are the orders finalised for certain patients based on strong indication to do so, like patients with terminal illnesses and diseases with poor prognosis. Ethical principles in accordance with the law not only respect patient's rights, but also authorise them to exercise their autonomy to consciously opt for DNR.[30] This statement, though legally valid and taken after discussion between patients, family and physicians, creates a paradox when these patients land up with surgical problems of acute nature or for symptom palliation, like surgical intervention for intestinal obstruction, fixing a bony fracture, performing tracheostomy or gastrostomy, and similar other procedures. The issue of DNR becomes conflicting as most of the management deployed by the anaesthetist is, in fact, resuscitative in nature and, hence, it is essential to have 'suspension of DNR orders' only to be restored when the acute care is over.[31] It has both ethical and clinical implications as patients may develop cardiac arrest as a result of anaesthetic or surgical intervention(s) and the condition is reversible with cardio-pulmonary resuscitation. An individualised decision without compromising the institutional policy is mandatory to adopt a holistic approach in the management of such patients whenever they require surgical intervention in the OR.[32]

Conclusion

Surgeons face potential ethical problems in OR which could be daily issues or complex situations requiring decision from limited available options. The surgeons should not only be skilled in the science and art of surgery, but should be cognisant of the ethical and moral problems and their solutions in the OR. Adherence to the ethical principles in OR creates a sense of responsibility among surgeons and a sense of trust, privacy and autonomy among the patients, which together can get translated into improved clinical outcomes.

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NARRATIVE REVIEW

In a digitally connected world through Likes, Hashtags and Followers — Advancing surgical research through a social media: A narrative review

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Abstract

In this era of modern information technology, the world is now digitally connected through various platforms on social media, which has changed the way medical professionals work, communicate and learn. The use of social media in surgery is expanding, and it is now becoming an essential tool for surgical training, research and networking. Articles, journal clubs and surgical conferences are within reach of everyone regardless of geographical location worldwide. Electronic publications have now resoundingly replaced printed editions of journals. Collaborative research through social media platforms helps collect diverse data, enhancing the research's global generalisability. The current narrative review was planned to discuss the importance of social media in advancing surgical research and the use of different social media applications in the context of promoting and disseminating surgical research alongside its evolving ethical challenges.

Keywords: Surgical research, Social media, Collaborative research, Ethics, Virtual presentations.

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Introduction

With the rapid advancement in information technology (IT), social media (SM) has become widespread and an essential tool for networking, communication and content-sharing in all disciplines of life. The reach of SM in modern society is extensive, with an estimated 2.46 billion users across all platforms reported in 2017.[1] It is estimated that the average person spends nearly 2 hours per day using SM in any form. The use of SM in healthcare also continues to expand. It is used as an essential resource for disseminating knowledge related to different ailments and their most updated available treatment options.

The field of surgery and surgical research is no different. In surgery, SM rapidly presents new avenues and has revolutionised every aspect of a surgeon's personal and professional life. The reported benefits include facilitating patient education, sharing information on new guidelines or published research, and increasing collaboration among the stakeholders, including patients, clinicians, trainees and educational institutions. However, some surgeons consider SM a gimmick designed to attract media attention even if alongside increasing the dissemination of research and knowledge.[2] Through generating online content, surgeons can increase the perception of their expertise in an online community, while patients use SM to find surgeons and to communicate about procedures and outcomes. During the ongoing coronavirus disease-2019 (COVID-19) pandemic, SM provided a means for rapid, international collaborative dissemination of data, management protocols and epidemiological findings.[3]

SM is an effective avenue for health professions and social sciences.[4] In this digital era, the surgical field has grown into a vast society where new ideas are shared and assimilated rapidly through a tap on a screen across multiple SM applications. SM offers an abundance to the present and future of surgical research due to its easy accessibility, low cost and global outreach. SM has been leveraged to share manuscripts and engage in collaborative academic discussions, allowing greater visibility and reach of surgical research findings[5]. Various SM platforms focus on establishing networks and promoting communications that will enable rapid dissemination of knowledge and actual results of the latest surgical research across the globe. Enrolling volunteers, engaging students and surgical trainees, and connecting with experienced surgeon researchers are now relatively straightforward. Moreover, SM applications have helped conduct live scientific sessions and conferences that allow remote but digitally connected surgeons easy access to the latest surgical researches. A consensus paper in 2020 recommended the use of SM by surgical trainees to promote their skills and interests in surgical research.[3]

The mass dissemination and discussion of research on SM are also supported by many reputable journals, some of which also calculate an alternative metric, or altmetric, that takes into account SM engagement of

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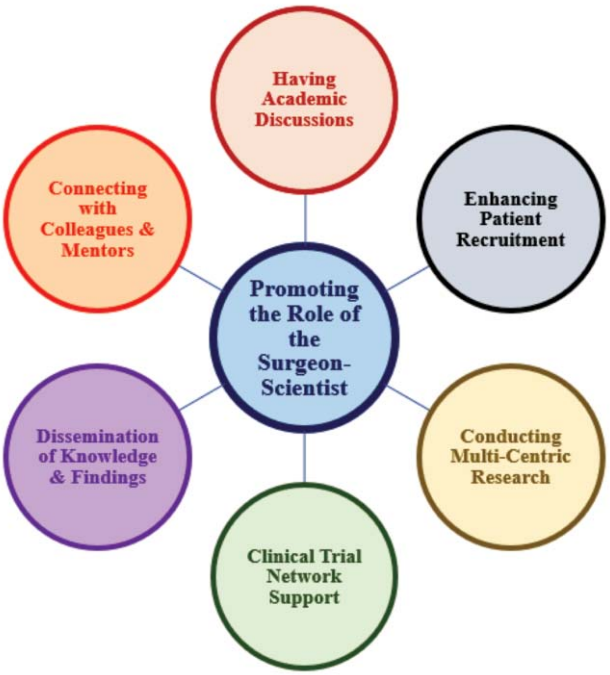

Figure: Ways in which social media facilitates the surgeon in conducting surgical research.

publications.[2,6] Some journals even offer to provide post-publication SM dissemination of research via their SM platforms.[7] In short, SM is now facilitating every possible aspect of a surgeon's research aspirations (Figure).

Commonly used SM apps in surgical research

Various SM applications have enabled surgeons to disseminate their scientific work through different collaborative platforms for surgical research, connecting surgeons through their shared interests in surgical research (Table). Each of these SM applications has a role in advancing surgical research.

Twitter: With more than 192 million daily users worldwide, and its brief content, Twitter is now serving as a beautiful microblog platform for conducting and promoting surgical research. Surgeons have turned to Twitter to disseminate valuable information on surgical diseases and raise new surgical research questions. Academic and research institutions responsible for surgical training and research run their own Twitter accounts to give the latest updates related to surgical research. Medical journals share recent articles on Twitter, promoting research in a fast and effective way. The popularity of Twitter for disseminating surgical research has overgrown over the past few years. The development is evidenced by conference-specific hashtags facilitating international discussion, journal-specific journal clubs enabling post-publication peer review, and sharing results of novel surgical techniques via live surgical coverage. Twitter hashtags at medical conferences have revolutionised how healthcare professionals interact, advance their education, and spread their novel research ideas. Studies have shown that Twitter improved medical conferences' online participation from year to year by documenting increasing numbers of tweets, users and impressions.[8,9] After promoting a hashtag at the conference, one study found that the organisational profile showed a 20% increase in followers over the following week.[10] Various research academies and institutions that offer a wide variety of surgical research courses have official Twitter accounts that include participants nationally and globally. Novel strategies to increase attention to postings of journal content have also been employed, such as using a visual abstract, which is a concise graphic summary of the main findings of an article. Data suggests that this does drive traffic to a journal's website by up to threefold.[11,12]

Table: Social media platforms used in surgical research and their mode of engagement.

Name	Logo	Engagement Method
Twitter		Hashtags, Retweets, Follows, Comments, Stories
Facebook		Likes, Comments, Follows, Joining Pages
Instagram		Reactions, Comments, Stories
Linked in		Connections
ResearchGate		Followers, Project Creation
Sermo		Provide Insights, Engage in Discussions

Facebook: Facebook is the oldest SM platform of the modern digital era and enables a diverse range of people to interact. Closed SM groups over Facebook offer unique opportunities to surgical researchers for conducting and promoting their work. It provides them with a method for rapid communication to advertise themselves and their novel research, and plays a substantial role in their professional development and advocacy. Surgeons and scientists use Facebook to disseminate and exchange information, education, research recruitment and community consultation for clinical trials. Facebook is widely used to increase the distribution of an article's message, and to potentially increase the dissemination of the article itself. Conferences on surgical innovations and research hold live sessions on Facebook, enhancing their accessibility to the target audience.[6] Closed groups on Facebook develop collaboration among the researchers by asking questions, recruiting data and enrolling other researchers with common interests.

LinkedIn: LinkedIn is a platform that is mainly used for professional networking. LinkedIn allows members to create profiles and connect in an online social network which may represent real-world professional relationships. Surgical associations have LinkedIn accounts that help them to promote surgical innovation and research. Conference proceedings and visual abstracts are notified to followers and give easy access to the latest research in surgery.[6] Members can get connected with well-accomplished surgical researchers and scientists.

ResearchGate: It is an European commercial social networking site for scientists and researchers to share papers, ask and answer questions, and find collaborators. ResearchGate members can upload research output, including articles, data, chapters, standalone results, research proposals, methods, presentations, etc. Account-holders can follow other researchers and also invite their co-authors to this SM platform. ResearchGate also calculates a Research Interest (RI) score for users and provides citation metrics. This platform is getting very popular among surgical researchers to aid networking with experts.[6]

Sermo: With over 800,000 users, Sermo is the world's most oversized virtual lounge for doctors. It has revolutionised real-world medicine by connecting doctors online to share wisdom and insights with their peers locally and globally.[6] On Sermo, users can share their points of view, unite and be heard. This virtual platform is now helping many surgeons design research questions, seek expert opinions, and conduct quality research.

Collaborative surgical research through social media

SM has made it easier than ever before to conduct multi-centre surgical research, as it offers the opportunity to collectively accumulate surgical data from multiple centres with relative ease.[5] SM has been used as a platform for patient recruitment for surgical trials[1] and several major global cohort studies. The GlobalSurg, the Student Audit and Registry in Surgery (STARSurgUK), the COVIDSurg and the COVIDSurg Cancer collaboratives are examples of multi-centre, collaborative, surgical initiatives.[7,13] Moreover, SM also allows instantaneous widespread virtual access to sample populations geographically or otherwise inaccessible. In Pakistan, a survey of women surgeons disseminated via SM provided a large, representative sample otherwise unachievable due to the lack of any formal central connecting platform for surgeons in the country.[14] Lastly, SM also promotes innovative research collaborations in surgery, which are fostered due to the increased cross-disciplinary online interactions between surgeons and technology personnel, such as engineers, biomedical researchers and data scientists.[7]

Other applications of SM in surgical research include real-time conference posts and updates, multidisciplinary journal clubs, and surgical research skill-building opportunities.[13] SM also serves as a platform for reputable surgical organisations, like the Association for Academic Surgery, to connect and communicate with surgeons globally regarding announcements, career opportunities, research and other awards, and scientific advancements.[7] Moreover, SM platforms also provide surgeons unique access to professional and research mentorship,[15] crucial for women surgeons who otherwise lack the exposure and opportunities to interact and collaborate with same-gender role models.[16]

Ethical challenges in conducting surgical research through SM

While SM plays a significant role in facilitating, attracting and glamourising research and researchers, professionalism and integrity may be compromised, often unintentionally.[17] There are several potential risks as well as regulatory and ethical concerns associated with the use of SM that surgeons, trainees, and health institutions need to be aware of, as information may be permanently shared with millions.[18] The researchers must be mindful of the complex ethical dilemmas associated with SM research, like subject recruitment, consent and autonomy, confidentiality, and risk to the researcher.

Subject recruitment: SM platforms offer unique and cost-effective opportunities for recruitment and intervention in the context of surgical research, particularly for studying health topics that are highly stigmatised, while connecting with populations that are hard to reach.[19] However, when compared to the standard recruitment methods, some studies have identified issues, like low recruitment accrual due to a possible mismatch between the target group and the SM platform used, or an overall presentation of the call-out/advertisement for the recruitment; and unrepresentative samples, especially when incentives are offered or when non-specific SM platforms are used.

Consent and autonomy: In the case of SM or internet research, the question of when and how specific, informed consent should be obtained becomes challenging because the large volume of SM data makes it difficult to obtain informed consent from all users, as data cannot be easily tied to an identifiable individual; when some

organisation has provided a list of potential participants, the members may not have been informed or taken consent from; though information may be posted on individuals' public profile, it does not mean that they have consented to this data to be used for research;[20] and consent/exemptions for public datasets cannot be substituted as blanket permission for all SM research.

Data handling: Anonymity, confidentiality, and privacy: Owing to the public nature and varied use of SM for research, the emerging ethical issues revolving around privacy are complex, and the principles of anonymity and confidentiality are much more challenging to uphold. This is particularly true when individuals can be identified/traced directly through their Internet Protocol (IP) address or the internet links related to the website included in the research or through data retrieved/collected from the SM platforms, such as Twitter.[21,22]

In addition, ethical issues surrounding data and image storage or destruction remain. Visual data, such as photographs posted on Facebook or Instagram, may pose a substantial risk to research participants' privacy and may even be subjected to potential manipulation. Even publicly available data may be considered private and sensitive by the user and requires protection to avoid hacking, identity theft, and data ownership.

Most platforms allow users to have 'pseudonymous' identities. They can engage in practices intended to facilitate non-identifiable content, but this in itself presents a unique ethical challenge to the principle of anonymisation.[23]

There is yet another perspective to participant and data confidentiality. Rarely, though, the subjects of clinical trials may breach the confidentiality for want of recognition for participating and/or contributing to the research.[24]

Risk to the researcher: SM is also being used to create one's professional presence by maintaining work relationships. But in the absence of appropriate disclaimers, a surgeons' posts might be viewed as medical advice, leading to potentially litigious consequences. Surgeons may also begin online communication with patients, inadvertently beginning doctor-patient relationships outside the usual clinical encounter, which may have legal implications.

Moreover, unintentionally posting unprofessional content on SM where the personal and professional identities are not separated may violate professional conduct. This allows the public to make judgments about health professionals and renders them more susceptible to what one may call SM harassment in the form of hate speeches or threats.[25]

Possible counter measures for avoiding ethical challenges

In 2010, the American Medical Association (AMA) released official guidelines for physicians' ethical use of SM.[26] These guidelines emphasise the need to maintain patient confidentiality, to be aware of privacy settings, to maintain appropriate patient-physician boundaries, to provide accurate and truthful information, and to act with collegiality.

Often it becomes difficult to differentiate between public and private cyberspace and the data available online on these spaces. If anyone can access the data without website registration or membership, it can be considered the internet's public domain. In contrast, password-protected data or websites requiring registration should be considered a private domain.

It is evident from literature that ethical SM research means differently to different disciplines and researchers, depending on their positionality and research method. The existing ethics review committees (ERCs) may be struggling to deal with the emerging technologies, and their implications and should not be solely relied upon as the moral compass. The researchers should report on the ethical dilemmas in their practice to guide the others, including the ERCs. There is a need for an ongoing process in which the researcher, the participants, and the ERCs work together to identify potential problems to the ever-evolving SM technology and use and find contextually relevant solutions.[27]

Conclusion

In recent years, SM has become as a precious platform in advancing surgical research. It has opened new avenues for surgical researchers to expand their research and get digitally connected with their peers and experts across the globe. Collaboration among researchers is now increasing through SM. However, some ethical challenges unique to the SM must be considered for its safe and effective use.

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REVIEW ARTICLE

A bibliometric analysis of the studies on dental implant failure

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Abstract

Objective: To identify top 30 studies related to dental implant failures based on bibliometric analysis.

Methods: The bibliometric study was conducted at Aga Khan University, Karachi from April 2021 to June 2021 and comprised database search on Google Scholar used key words "dental implant failures" for studies published between 1990 and 2020. The selected studies were reviewed based on citation count for which the cut-off date was June 1, 2021.

Results: The top 30 papers on dental implant failures had median citation count of 153 (range: 41-1583. Most of the studies were retrospective 11(36.7%), followed by literature reviews 6(20%). The top three contributing journals were the 'International Journal of Oral Maxillofacial Implants' 6(20%), the 'Clinical Oral Implants Research' 5(16.7%) and 'Clinical Implant Dentistry and Related Research' 3(10%). Goteborg University, Sweden, contributed the maximum number of most cited papers 8(26.7%).

Conclusions: Most of the papers in the top-cited on dental implant failures were retrospective studies, and there was only one clinical trial.

Keywords: Dental implants, Dental implant failure, Bibliometrics.

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Introduction

Healthcare professionals update themselves with the current scientific literature using electronic media, conferences, textbooks and peer-reviewed journals.[1] The published scientific literature is growing exponentially and it is estimated that the volume of literature in health sciences doubles every 7 years.[2] This places the clinicians and researchers in a challenging situation of keeping abreast with the recent knowledge and practices.[3,4] Bibliometric analysis helps the reader to recognise the most acknowledged articles on the topics of interest.[5] It gives a snapshot of the must-read articles on the given topic. Different parameters are evaluated in the bibliometric analysis, including the citation analysis, which is a simple measure of counting the number of times a particular paper has been cited by other publications.[6] It is a commonly evaluated parameter in bibliometrics. Papers which are recognised to have significant bearing on a discipline get acknowledged more than the other papers with less impact.[7] Bibliometric analysis identifies variables such as country, institutions, authors and journals contributing to the discipline of interest.[8,9] All of this helps the researchers in designing further studies and thus contributing to the scientific enquiry.[10,11]

With abundant literature already present in various specialties of Medicine, Dentistry, Nursing and Allied Health Sciences, an inquisitive mind might ask the question as to what makes an article a 'classic article'. The definition varies, but a citation count (CC) >400 is usually considered the cut-off.[12] In certain specialties, due to limited volume of literature, CC >100 may be considered classic.[13] However, Giatsidis et al. suggested that rather than the CC, the citation density (CD) should be considered the valid parameter in evaluating the impact of an article.[14]

The current study was planned to identify top 30 studies related to dental implant failures based on bibliometric analysis which could be helpful in formulating the syllabus for short-listing the papers that can be recommended as a must-read or suggested-read in the residency programmes, seminars and journal clubs related to residency/fellowship training programmes in Prosthodontics, Oral Surgery or Implant Dentistry Implantology.

Materials and Methods

The bibliometric study was conducted at Aga Khan University, Karachi from April 2021 to June 2021 and comprised database search on Google Scholar used key words "dental implant failures" for studies published between 1990 and 2020. The citation analysis was carried out on June 1, 2021. Only English-language papers were considered, and there were no exclusions made based on study design. There were 18,900 hits on that search.

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The title, year of publication, authors, CC, CD, key words, the name of institution and the country of the corresponding author were recorded. After the screening process, the articles were arranged in the descending order based on CC.

Results

The top 30 papers on dental implant failures had median citation count of 153 (range: 41-1583. Of the total, 4(13.3%) would be labelled as classic with CC >400 (Table-1).

Table-1: Citation analysis of top 30 studies on dental implant failures.

#	Title	Citations		Article Type	Country	Key Words
		n	CD			
1	Esposito M, Hirsch JM, Lekholm U, Thomsen P. Biological factors contributing to failures of osseointegrated oral implants,(I). Success criteria and epidemiology. Eur J Oral Sci. 1998;106:527-51.	1583	69	Systematic Review & Meta-analysis	Uppsala University, Sweden	Dental implants; osseointegration; medical device failure; meta-analysis
2	Lindquist LW, Carlsson GE, Jemt T. A prospective 15-year follow-up study of mandibular fixed prostheses supported by Osseointegrated implants. Clinical results and marginal bone loss. Clin Oral Implants Res.1996;7:329-36.	891	37	Prospective study	Goteborg University, Sweden	Bone resorption, dental implantation, dental prosthesis, longitudinal study, oral hygiene, osseointegration, smoking
3	Zarb GA, Schmitt A. The longitudinal clinical effectiveness of osseointegrated dental implants: the Toronto study. Part III: Problems and complications encountered. J Prosth Dent.1990; 64:185-94.	838	28	Audit	University of Toronto, Canada	No key words
4	Fransson C, Lekholm U, Jemt T, Berglundh T. Prevalence of subjects with progressive bone loss at implants. Clin Oral Implants Res. 2005; 16:440-6.	450	29	Retro-spective charts review	Goteborg University, Sweden	Bone level, complications, dental implants, human radiographs
5	Roos J, Sennerby L, Lekholm UL, Jemt T, Gröndahl K, Albrektsson T. A qualitative and quantitative method for evaluating implant success: a 5-year retrospective analysis of the Brånemark implant. Int J Oral Maxillofac Implants. 1997;12:504-14.	379	16	Retro-spective study	Goteborg University, Sweden	Brånemark system, criteria for evaluation, retrospective study, titanium implants
6	Bain CA. Smoking and implant failure--benefits of a smoking cessation protocol. Int J Oral Maxillofac Implants.1996;11:756-9.	366	15	Prospective study	Dubai School of Dental Medicine	Implant failure, risk factor, smoking, smoking cessation benefits
7	Hardt CR, Gröndahl K, Lekholm U, Wennström JL. Outcome of implant therapy in relation to experienced loss of periodontal bone support: a retrospective 5-year study. Clin Oral Implants Res. 2002;13:488-94.	328	18	Retro-spective Study	Goteborg University, Sweden	Bone loss, osseointegration, partial edentulism, periodontitis, posterior maxilla, titanium implants
8	Chrcanovic BR, Albrektsson T, Wennerberg A. Reasons for failures of oral implants. J Oral Rehabil. 2014;41:443-76.	300	46	Review Paper	Goteborg University, Sweden	Dental implants, failure, associated conditions, systematic review
9	Porter JA, Von Fraunhofer JA. Success or failure of dental implants? A literature review with treatment considerations. Gen Dent. 2005; 53:423-32.	280	19	Review Paper	University of Maryland, USA.	No key words
10	Snauwaert K, Duyck J, van Steenberghe D, Quirynen M, Naert I. Time dependent failure rate and marginal bone loss of implant supported prostheses: a 15-year follow-up study. Clin Oral Invest. 2000;4:13-20.	223	11	Cohort Study	Catholic University of Leuven, Belgium	Oral implants · Dental implants Osseointegration failures Marginal bone loss · Brånemark system
11	Esposito M, Thomsen P, Ericson LE, Lekholm U. Histopathologic observations on early oral implant failures. Int J Oral Maxillofac Implants. 1999;14: 798-810.	201	10	Histo-pathologic evaluation	Goteborg University, Sweden	Dental implant, early failures, morphology, titanium, ultrastructure
12	Sakka S, Baroudi K, Nassani MZ. Factors associated with early and late failure of dental implants. J Invest Clin Dent. 2012;3:258-61.	200	25	Review Paper	Al-Farabi Dental College, Saudi Arabia	Dental implants, early failure, late failure, osseointegration.
13	Listrom RD, Symington JM. Osseointegrated dental implants in conjunction with bone grafts. Int J Oral Maxillofac Implants. 1988;17:116-8.	187	6	Case Series	Toronto General Hospital, Canada	Implant dental, titanium, osseointegration, graft bone
14	Sun HL, Wu YR, Huang C, Shi B. Failure rates of short ($\leq$ 10 mm) dental implants and factors influencing their failure: a systematic review. Int J Oral Maxillofac Implants. 2011;26: 816-25.	182	20	Systemic Review	Wuhan University, China	Bone quality, dental implants, implant length, implant position, implant surface
15	Chung DM, Oh TJ, Lee J, Misch CE, Wang HL. Factors affecting late implant bone loss: a retrospective analysis. Int J Oral Maxillofac Implants. 2007;22:117-26.	158	11	Retro-spective Study	University of Michigan, USA	Implant maintenance, implant surfaces, late implant bone loss, peri-implantitis
16	Manor Y, Oubaid S, Mardinger O, Chaushu G, Nissan J. Characteristics of early versus late implant failure: a retrospective study. J Oral Maxillofac Surg. 2009;67:2649-52.	149	14	Retro-spective Study	Tel Aviv University, Israel	No key words
17	Albrektsson T. On long-term maintenance of the osseointegrated response. Aus Prosthodont J. 1993;7:15.	144	5	Review	Goteborg University, Sweden	No key words
18	Kronström M, Svenson B, Hellman M, Persson GR. Early implant failures in patients treated with Brånemark System titanium dental implants: a retrospective study. Int J Oral Maxillofac Implants. 2001;16.	135	7	Retro-spective study	Central Hospital, Sweden	Early implant failure, endosseous dental implantation, osseointegration, titanium

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19	Tabanella G, Nowzari H, Slots J. Clinical and microbiological determinants of ailing dental implants. Clin Implant Dent Rel Res. 2009;11:24-36.	130	11	Cross sectional study	University of Southern California, USA	Oral implants, peri-implant bone loss, peri-implantitis, peri-implant tissue, predictors of ailing dental implants
20	Schwartz-Arad D, Laviv A, Levin L. Failure causes, timing, and cluster behavior: an 8-year study of dental implants. Implant Dent. 2008;17:200-7.	128	10	Audit	Schwartz-Arad Surgical Center, Israel	Dental implants; implant failure; success; survival; cluster pattern; prosthetic phase; surgical phase
21	Sakka S, Coulthard P. Implant failure: etiology and complications. Med Oral Patol Oral Cir Bucal. 2011;16(1):e42-4.	124	13	Review Paper	University of Albath, Syria	Implant failure, peri-implantitis, marginal bone loss, implant mobility
22	Chen S, Darby I. Dental implants: Maintenance, care and treatment of peri-implant infection. Aus Dent J. 2003;48(4):212-20.	124	7	Review Paper	University of Melbourne Australia	Osseointegration, peri-implant mucositis, periimplantitis.
23	Tonetti MS. Determination of the success and failure of root-form osseointegrated dental implants. Adv Dent Res. 1999;13:173-80.	102	5	Prospective study	University of Bern Switzerland	Dental implants, infection, biomechanical overload, risk, survival, susceptibility, review.
24	Esposito M, Thomsen P, Mölne J, Gretzer C, Ericson LE, Lekholm U. Immunohistochemistry of soft tissues surrounding late failures of Brånemark implants. Clin Oral Implants Res. 1997;8:352-66.	94	4	Immuno-histochemistry study	Goteborg University, Sweden	Dental implants, titanium implant failure, macrophages, immune cells,
25	Tolstunov L. Dental implant success-failure analysis: a concept of implant vulnerability. Implant Dent. 2006;15:341-6.	75	5	Review Paper	University of Pacific School of Dentistry, USA	Osseointegration; implant vulnerability; bone connection; natural teeth; ankylosed teeth
26	Gabbert O, Koob A, Schmitter M, Rammelsberg P. Implants placed in combination with an internal sinus lift without graft material: an analysis of short-term failure. J Clin Periodontol. 2009;36:177-83.	74	6	Clinical Trial	University Hospital Heidelberg, Germany	Dental implants; graft; internal sinus lift; osteotome; sinus floor elevation
27	Wu X, Al-Abedalla K, Rastikerdar E, Abi Nader S, Daniel NG, Nicolau B, Tamimi F. Selective serotonin reuptake inhibitors and the risk of osseointegrated implant failure: a cohort study. J Dent Res. 2014; 93:1054-61.	72	12	Cohort Study	McGill University, Canada	Medical devices, risk factors, dental implants, bone remodeling, osseointergration, epidemiology
28	Vervaeke S, Collaert B, Cosyn J, Deschepper E, De Bruyn H. A multifactorial analysis to identify predictors of implant failure and peri-implant bone loss. Clin Implant Dent Rel Res. 2015;17:e298-307.	70	12	Retro-spective cohort study	Faculty of Medicine & Health Sciences, Ghent University, Belgium	Dental implant, implant survival, multifactorial, peri-implant bone loss, predictor
29	Zhou Y, Gao J, Luo L, Wang Y. Does bruxism contribute to dental implant failure? A systematic review and meta-analysis. Clin Implant Dent Rel Res. 2016;18:410-20.	64	14	Systematic review and meta-analysis	Wuhan University, China	Bruxism, complication, dental implant, implant failure
30	Schimmel M, Srinivasan M, McKenna G, Müller F. Effect of advanced age and/or systemic medical conditions on dental implant survival: A systematic review and meta-analysis. Clin Oral Implants Res. 2018;29:311-30.	41	19	Systematic review and meta-analysis	University of Bern, Switzerland	Aging, Alzheimer's disease, bisphosphonates, cancer, cardiovascular disease, chronic obstructive pulmonary disease, cirrhosis of the liver, dementia, dental implants, stroke, systematic review.

n: Citation count, CD: Citation density.

Table-2: List of top authors, journals, institutions and countries contributing to the most cited papers on dental implants failure.

Top authors		Article serial # (as shown in table 1)	Count*
1	Lekholm U	1,4,5,7,11,24	6
2	Albrektsson T	5,8,17	3
3	Esposito M	1,11,24	3
4	Jemt T	2,4,5	3
5	Thomsen P	1,11,24	3
Top journals			
1	International Journal of Oral & Maxillofacial Implants	5,6,11,14,15,18	6
2	Clinical Oral Implants Research	2,4,7,24,30	5
3	Clinical Implant Dentistry and Related Research	19, 28,29	3
Top institutions			
1	Goteborg University, Sweden	2,4,5,7,8,11,17,24,	8
2	University of Bern, Switzerland	14,29	2
3	Wuhan University, China	23,30	2
Top countries			
1	Sweden	1,2,4,5,7,8,11,17,18,24	10
2	United States of America	9,15,19,25	4
3	Canada	3,13,27	3

*Only top 3-5 articles are reported, and, therefore, the numbers do not necessarily sum up to 30.

Table-3: Study designs of the selected papers.

No.	Study design	Article serial # (as shown in table 1)	Count
1	Systematic review / Meta-analysis	1, 14, 29, 30	4
2	Clinical trial	26	1
3	Prospective study/ Cohort	2, 6, 10, 27	4
4	Retrospective study/ Case-control	3, 4, 5, 7, 15, 16, 18, 20, 23, 25, 28	11
5	Cross sectional study	19	1
6	Literature review	8, 9, 12, 17, 21, 22	6
7	Case report/ Case series	13	1
8	Histopathology/ Immunohistochemical investigation	11, 24	2

The top three contributing journals were the 'International Journal of Oral Maxillofacial Implants' 6(20%), the 'Clinical Oral Implants Research' 5(16.7%) and 'Clinical Implant Dentistry and Related Research' 3(10%), while the Goteborg University, Sweden, contributed the maximum number of the most cited papers 8(26.7%) (Table-2).

Most of the studies were retrospective 11(36.7%), followed by literature reviews 6(20%) (Table-3).

Discussion

Dental implants have been popularised by Dr Branemark, a Swedish orthopaedic surgeon and scientist.[15] He revolutionised the field of Dental Implantology with the introduction of titanium-based endosseous dental implants and the discovery of the phenomenon of osseointegration. Dental implant has become a popular method of replacing teeth worldwide. To date, millions of people have benefitted from dental implants. However, despite high predictability in the outcome of implants, a small but important subset of patients do experience failure.[16,17] Subjects with osteoporosis, low bone volume, poor quality of bone, presence of metabolic bone disease, use of bisphosphonates and history of progressive periodontal disease etc. are at a greater risk of implant failure. Both the quality and quantity of bone that supports and surrounds the implant influence the osseointegration of implant.[18-20]

Implant failures are categorised as early and late failures.[21] Early implant failures are caused by poor bone quality, medically compromised patients, like those with uncontrolled diabetes, inadequate surgical technique, chronic drug or alcohol consumption, and smoking status, whereas late causes of failures are occlusal overload/excessive stress, peri-implantitis and poor oral hygiene, and defective implant components.[17,22,23] The most common reasons for late or delayed implant failure include implant overloading or fracture, and/or peri-implantitis.[22]

Bibliometric analysis can serve as a useful tool for clinicians and researchers to appraise published literature on a given topic.[7] The current study was carried out to identify the papers on dental implant failures that have the maximum impact on the knowledge and understanding of this topic. Ten out of the 30 top-cited papers on dental implant failures were from Sweden. This shows that Swedish researchers are at the forefront of research on dental implant and its failures.

Most of the papers in the top-cited list were retrospective studies and audits. It is logistically easier to carry out and publish retrospective studies as mostly there are no issues of funding associated with them. Moreover, the sample size or number of observations are usually higher, resulting in comparatively easier publication. In the present report, 11 of the 30 studies had retrospective study design. The importance of systematic reviews and meta-analysis cannot be underestimated, as they synthesise data from primary studies to yield the highest level of evidence that forms the basis of the evidence-based practice (EBP).[24,25] In the present report, there were 4 systematic reviews/meta-analyses. Two of them were conducted at Wuhan University, China.

Literature reviews and narrative reviews do not provide a high level of evidence, and they have inherent biases. Despite increasing emphasis on evidence-based dentistry (EBD), it is worrying to observe that in the present list, 6 articles were literature reviews. The lack of randomised controlled trial (RCTs) in the list is a matter of concern. Ideally, owing to the level of evidence generated, the clinical trials should be cited more than the retrospective studies.

The limitation of the current study is that it has listed the paper based on CC which actually reflects the popularity of a paper rather than its true clinical significance and the impact on practice. Moreover, starting the literature search from 1990 was an arbitrary starting point, mainly to cater to electronically published papers as prior to 1990, several journals had print-only editions. Some important papers published before the cut-off point could have made it to the top cited list but were left unattended. Lastly, non-English literature was ignored, making citations from non-English literature, especially from Chinese, South Korean or Brazilian publications, excluded.

Conclusions

The CC of the top 30 papers on dental implant failure ranged from 41 to 1583. Most of the papers in the top

cited list were retrospective studies, followed by literature review and systematic reviews. There was only one clinical trial in the list.

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REVIEW ARTICLE

Current perspectives of oncoplastic breast surgery in Pakistan

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Abstract

Oncoplastic breast surgery is based on the concept of tumour-specific immediate reconstruction. It combines both local and distant techniques to maintain breast texture, symmetry and cosmesis without compromising oncological outcome. The current narrative review was planned to highlight the current state and future of oncoplastic breast surgery in low- and middle-income countries where its utilisation in surgical practice remains insubstantial because majority of the surgeons who are treating breast cancer are either general surgeons or breast surgeons who do not have expertise in oncoplastic breast surgery or reconstructive surgery. Moreover, scarcity of financial resources, ignorance about oncoplastic breast surgery techniques, disfigurement distress and cultural taboos coerce women to hide in the shadows with their breast disease. Oncoplastic breast surgery needs more exposure in a developing country like Pakistan. There is a need to establish dedicated oncoplastic breast surgery training centres, fellowship programmes, workshops, and webinars to incorporate such techniques in the practice of breast surgeons.

Keywords: Oncoplastic surgery, Reconstruction, Low and middle-income countries, Breast cancer, Breast conserving surgery.

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Introduction

The first registered description of an attempt to reduce a female breast was by the Will Duston in 1670.[1] Two centuries later, in 1882, T. Gaillard Thomas from New York was the first one to integrate an incision at the mammary sulcus and reduce a breast with the intention to excise a benign tumour.[2] Oncoplastic surgery (OPS) of the breast began its journey around the mid-1970s as reductive techniques started to be performed expeditiously for breast cancer patients. It was also at this time when the first data from the Milan trial comparing breast-conserving surgery (BCS) together with radiotherapy (RT) and traditional Halsted mastectomy showed no difference in terms of local recurrence and overall survival.[3,4] In 1993, the term 'oncoplastic' was first mentioned at the Santa Fe Symposium of Breast Surgery and Body Contouring. Few years later, its founding principles were explained in a published article.[5] Since then, OPS has seen rapid and consistent development as a competitive medical practice for breast surgeons, making great progress and getting acceptance among patients and medical society.

Originally developed to aid in the management of complex tumour sites within the breast, the word 'oncoplastic' explains itself by performing tumour-adapted oncological safe procedures along with cosmetically outstanding breast reconstructions. OPS covers the technique and art of tumour-specific immediate breast reconstruction applicable to BCSs as well as in conservative mastectomy. In this sense, OPS has the potential to deal with very complex breast cancer patients by providing the surgeon a wide spectrum of medical tools, surgical techniques and back-up plans. Handful of original and review articles have been present in literature, focussing on the rapidly gaining popularity of OPS techniques in developing countries.[6] The current narrative review was planned to highlight the prevailing state and future of breast OPS in low- and middle-income countries (LMICs).

Methods and Results

The narrative review was conducted at the Department of Breast Surgery, Aga Khan University Hospital (AKUH), Karachi, and comprised extensive literature search on PubMed and Google Scholar databases from the inception of the databases till June 2021 to explore all published original and review articles on OPS practices worldwide, especially in LMICs. Various combinations of the following terms were utilised during literature search: "Oncoplastic breast surgery", "Oncoplastic breast conserving surgery in Low-Middle income countries", "Oncoplastic techniques", and "Cosmetic outcomes of oncoplastic breast surgery".

Research articles published in languages other than English, duplicate publications and studies with incomplete data were excluded. Of the 300 articles identified, after consensus between two independent reviewers, 21(7%) were selected for detailed review.

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Discussion

The current review in the first from Pakistan addressing OPS breast conservation in a country that has a much higher incidence of breast cancer with many presenting with bigger tumour sizes.

OPS and new surgical possibilities: OPS was conceived to provide surgical techniques to treat very complex breast lesions. Large tumours with unfavourable anatomic localisations have always been a challenge in the treatment of breast cancer patients and there has been concerns regarding the oncological safety of surgical procedures without sacrificing cosmetic outcome. It is known that up to 30% of the women undergoing BCS will have a residual deformity amenable for cosmetic correction.[7]

Other complex clinical scenarios, such as breast cancer in patients with prosthetic breast augmentation, breast cancer recurrence with previously irradiated tissues secondary to breast conserving surgery, and patients with substantial deformities, are part of daily practice and are perfectly addressed by surgeons who have the knowledge and skills to perform OPS (Table-1).[8] There should be awareness that OPS is not a one-size-fits-all system and efforts should focus on individual oncological treatment protocols. Considerations regarding the relative size and tumour location, the anatomy of the breast and body, as well as patients' preference have all to be balanced to fulfil patient needs.

Local and distant control of the disease, improvement in overall survival, and quality of life, are primary endpoints in the care of breast cancer patients. The oncological intervention from the surgical point of view should always be in line with international standards regarding tumour management, resection margins, lymph node staging, pathology interpretation and processing of the tumour specimen. Special attention should be taken to cut down re-excision rates as much as possible, as this issue has great psychological impact on patients besides the additional costs.[9,10]

Table-1: Complex breast cancer patients managed by oncoplastic surgeons.

Breast cancer recurrence
Breast cancer in augmented patients
Previously radiated breast and skin tissue
History of lymphoma, mantle radiation to the thorax and secondary breast cancer
Breast cancer during pregnancy
BRCA Mutation
Aggressive tumour biology (i.e., triple negative, high grade tumors, etc)
Patients with heart pacemakers
High degree of distortion and asymmetry from previous surgery and radiotherapy

BRCA: Breast cancer gene A.

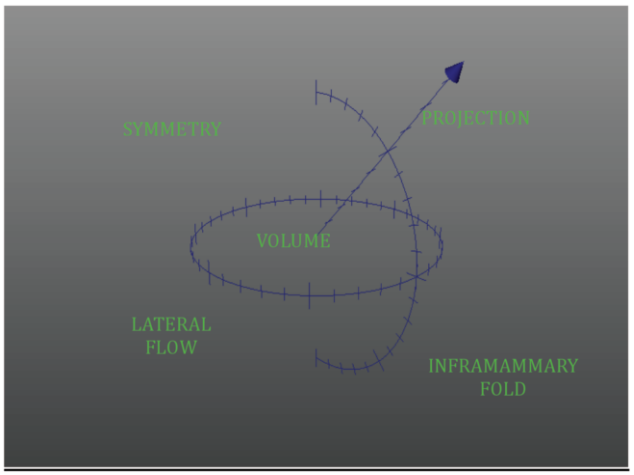

Figure: Principles to obtain a naturally shaped reconstructed breast.

Once the oncological procedure has been accomplished, the reconstructive phase begins, and it is at this point that the OPS becomes the best intervention to provide patients a functional and good quality of life. In the process of breast reconstruction, a complete understanding of the breast shape in a three-dimensional (3D) conception is needed.

There are multiple reconstructive options available to restore symmetry in BCS. They can be divided into three broad categories: volume displacement techniques using available gland parenchyma, fat, and skin to remodel and redistribute tissue; volume replacement techniques to fill up spaces with both local or distant flaps; and volume reduction techniques in cases when ptosis and volume improve as well. Either with the use of local or distant flaps, and autologous or prosthetic tissue, the success of the reconstruction is based on surgical principles of a meticulous tissue handling. Basic aspects of adequate blood supply to tissues, integration of scars from previous surgery, precise flap positioning and rotation, and tension-free closure, should be on the checklist to ensure a successful result. The final touch in "sculpturing and tailoring" tissues can be a true artistic challenge. Getting all the pieces together for the precise volume and projection, the accurate lateral flow and infra-mammary fold, will result in a naturally shaped and anatomic reconstructed breast[5] (Figure).

The essence of a competitive OPS clinical practice relies on surgical precision planning which means having a detailed and meticulous surgical workup for each patient.

OPS worldwide: OPS is being practised worldwide and the facility is available at most recognised breast cancer centres around the world. It is known that the quality of treatment and medical attention can be substantially

improved through specialisation, certification and external monitoring of breast cancer centres.[11]

Breast units are also associated with increased economic efficiency secondary to tight organisational structures, simplified patient routing, common purchasing and, to some extent, to the avoidance of multiple examinations.[12] The logistics and requirements to perform OPS can be pragmatically integrated processes practised at breast centres and hospitals. It is important to say that specialised breast cancer units are expected to oversee a large volume of cases. It has been calculated that an increase from 50 to 100 new breast cancer cases per year results in almost 50% reduction of average costs in the management of these patients.[13] This can be of particular interest to health systems with a limited budget struggling to find a way to optimise healthcare for breast cancer patients.

Certified OPS breast centres should be able to provide a clear and efficient network of care. Strong interdisciplinary work is a key for success in the treatment of these patients, and feedback is needed from all the involved medical fields, including surgery, medical oncology, radiotherapy, psychology and specialised nursing.

Prevailing state of OPS in LMICs: OPS has successfully made its way into LMICs over the past two decades and has become an effective surgical intervention of choice for women presenting with an early stage of breast cancer, complex anatomic locations, or non-responding disease to neo-adjuvant treatment. Data-driven evidence has also validated the expeditiously increasing popularity of OPS in LMICs.[6,14,15]

In Pakistan, a developing country, OPS is still in its nascent state associated with less popularity possibly because of factors related to patients and surgeons.[16] Patient-related factors may include underlying issues of low socioeconomic status, psycho-social taboos, false assumptions that mastectomy is associated with better survival, reliance on alternative therapies and lack of awareness of oncoplastic techniques. The surgeon-related factors may include paucity of training and education programmes in breast OPS that affect the decision-making process of surgeons, while many also believe that training in OPS might hinder their performance as an oncological surgeon.[17] Majority of the surgeons who are treating patients happen to be either general surgeons or breast surgeons with no expertise in OPS or reconstructive surgery. Many patients do not opt for OPS when they are advised to follow two surgeons separately for oncological and aesthetic part of the surgical procedure, and lack of OPS multidisciplinary team meetings also results in compromised cosmetic outcome as incisions or dissections performed by oncological surgeons are often either hamper the cosmetic outcome or require more complex procedure to maintain cosmesis. In private setups, patients usually choose the cost-effective procedure, which is a simple BCT or mastectomy, and none of the government hospitals in Pakistan has any trained Oncoplastic Surgeon. One of the biggest cancer institutions in Lahore has adequately trained OPS surgeons, but they do not offer level III OPS techniques or reconstruction to reduce operative cost. Compromised access to education and healthcare facilities, weak financial status because the majority of females are not earning members of their families, and religious reasons also contribute to surgical planning and decision. Breast cancer patients do not have much awareness about breast conservation, as females are hesitant to discuss available surgical portfolio for their disease with male surgeons where OPS/female surgeons are not available. Therefore, they drop the idea of any form of partial or total breast reconstruction.

Data published by a trained oncoplastic surgeon from Pakistan showed that patient acceptability and outcome improved when procedures were offered to suitable candidates, with promising cosmetic outcome and lesser complications which not only resulted in sharp decline in mastectomy rates among the young and the middle-aged, but also in the rate of re-excision with improved quality of life.[16,18]

The situation is much better in neighbouring India where there is a dedicated OPS centre and trained eminent OPS surgeons ensuring that the field is evolving fast despite the shortcomings. A structured training course has also been initiated, incorporating all the breast oncoplastic surgeons from India and the United Kingdom to provide detailed training of OPS principles and techniques. Surgical simulations, live mark-up sessions, workshops and doing operative interventions under the supervision of well-trained oncoplastic surgeons from across the globe helps in providing hands-on training to aspiring breast surgeons.[15]

The status and trends of breast OPS in other LMICs cannot be discerned as there is a paucity of published data.[6] The need of the time is to have One Oncoplastic Breast Surgeon-Dual Role Model. Essentially this is a more acceptable model as dual cost can be saved, the patient does not need to pay to two surgeons, one surgeon can handle both oncological and aesthetic aspects of the case, and provide better care and cosmetic outcome.[19]

The future of OPS: The future of OPS depends on further

Table-2: International Oncoplastic breast surgery (OPS) fellowship programmes.

Country / City	Hospital Breast Center	Program Director
Dusseldorf, Germany	Marien Hospital Breast Center	Prof. Werner Audretsch
Milan, Italy	Istituto Europeo di Oncologia	Prof. Mario Rietjens
London, Great Britain	Royal Marsden Hospital	Miss. Fiona McNeill
Barretos, Brazil	Oncoplastic Training Center	Dr. Gustavo Matthes
Paris, France	The Paris Breast Centre-L'Institut du Sein	Dr. Krishna Clough
Pune, India	Orchids Breast Health Clinic	Dr. C. Koppiker

medical innovations in breast cancer treatment and the dissemination of its founding basis and principles to the new generations of breast surgeons. This can only be accomplished through the development of competitive and formal training fellowship programmes for the specialisation of human resource in the OPS field.

Several fellowship programmes have been established worldwide and are committed with high standards of academic and practical training. Some international OPS fellowship programmes are more recognised than the rest (Table-2).

Although OPS training has had great impact on the specialisation of young breast surgeons, some challenges need to be faced and overcome. Important areas to be developed in OPS include a license approval on a global level, and the creation of an international committee to regulate adapted practice standards across different countries.

Most surgeons start practising oncoplastic techniques after attending few courses, which does compromise the aesthetic outcome with complications. Taking a single workshop on OPS training does not make one an expert in the technique. It is a journey, not a single course, which slowly and steadily needs to be integrated in one's practice. After all, mastery needs practice.[20]

In terms of limitations, published papers on the indexed search engines from LMICs are rather old, and, therefore, the references included in the current review are not recent.

Conclusion

Patients should be aware that aesthetic surgery is no contraindication to local control and cosmesis. Surgical precision planning is an OPS fundamental. Tumour-adapted surgery along with the integration of radio-chemotherapy can reduce the number of re-excisions, result in a better local control of the disease, and facilitate outstanding cosmetic outcomes. OPS has shifted the paradigm of making BCS an alternative not only for early breast cancer, but in all cases in which radiotherapy is mandatory. Ultimately, OPS is committed to providing the highest standard of care for breast cancer patients, making its future always very promising. Oncoplastic surgery can bring favourable change to surgical aspect of breast cancer management in LMICs by increasing the rate of breast conservations, reducing cost and workload, with lesser rate of re-excisions in already overburdened healthcare systems. There is a need to overcome the gap in practices between the developed and the developing worlds, and to train surgeons in this regard from developing countries.

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REVIEW ARTICLE

Disparities in access to quality surgical care for women in resource-constrained settings: Bottlenecks and the way forward

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Abstract

Women seeking surgical care are burdened with gender disparities, particularly in resource-limited settings. Such disparities can lead to women often presenting late with advanced disease and poor prognoses. The current narrative review was planned to find evidence for gender disparities, their implications, challenges faced by women seeking surgical care, and strategies to address them. Potentiating from interplay between various societal, sociocultural, and economic barriers, the main challenges included inadequate autonomy, financial constraints, transport and referral issues, lack of experienced women surgeons, privacy concerns, surgeon distrust, and higher thresholds for seeking care. While research revealed these underlying causes, much work remains for governmental healthcare bodies, the international community, surgical leadership, policymakers, surgeons, and family members of patients to act on the highlighted issues. Unrestricted access to quality surgical care for everyone is of vital importance, and can translate into a significant decrease in preventable disabilities and deaths among women in resource-constrained settings.

Keywords: Women, Surgery, Healthcare disparities, Sexism.

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Introduction

Nearly 5 billion patients lack access to quality surgical care worldwide, with a majority of them residing in low- and middle-income countries (LMICs).[1,2] Owing to societal, sociocultural and economic barriers, women in LMICs are disproportionately impacted.[3-5] Rectifying these gender disparities in unmet need for surgical care is imperative to improve women health and prognoses. The current narrative review was planned to find evidence for gender disparities in access to surgical care, to highlight the various challenges faced by women seeking surgical care, and to suggest strategies that can be employed to improve the situation.

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Evidence for gender disparity

Nearly 30% of the global burden of disease is attributed to surgical conditions. Despite this, an estimated 5 billion people lack access to safe and affordable surgical care when needed, particularly in LMICs.[2,6-8] While impediments in access to surgical care come from interplay of various social, economic and cultural factors, gender remains among the most pertinent barriers. Significant proportions of women are uneducated in LMICs, making them more vulnerable and dependent on their caregivers. Consequently, women often have limited autonomy in health-seeking decisions.[3-5] Research has shown that most women require permission from their husbands to seek surgical care.[9] This further contributes to gender disparities in access to quality surgical care.

A study conducted in Malawi on general surgery patients concluded that only 31.2% patients seeking surgical care were females. Moreover, women were provided more non-operative interventions when compared to men.[10] These disparities were also highlighted in an Indian study on congenital cardiac surgeries among children with only 37.6% patients being females.[11] Similarly, only 39.9% of all patients seeking surgical care at a global charity in the Republic of Congo were females.[12] Studies from Ethiopia and Ghana on paediatric surgical admissions also demonstrated fewer admissions for female patients compared to males.[13] In Bangladesh and Pakistan, women are less likely to seek surgical treatment for cataract than men.[14,15] Among patients with end-stage renal disease (ESRD) requiring transplantation, women had 11% less access to transplantation than men despite comparable survival benefits, and this difference was more pronounced in older age groups[16] (Table). In addition to access to surgery, gender disparities also exist in quality of perioperative care. A study on patients undergoing wrist arthroscopy found that women were less likely than men to utilise preoperative imaging modalities.[17]

Implications of gender disparities

The consequences of disparities in access to surgical care can be devastating. Nearly 80% deaths from surgical diseases occur in LMICs, and they are more common

Table: Evidence of gender disparity in access to surgical care in resource-limited settings.

Study	Setting	Inclusion criteria	Gender distribution	Additional findings
Reid et al, 2019[10]	Malawi	All patients undergoing general surgery	Males 318 (68.8%), females 133 (31.2%)	• Only 54% of women underwent surgery within 24 hours of presentation compared to 70% of men (P = 0.01). • Women had significantly delayed time to presentation (adjusted mean difference of 136 hours later than men) (P = 0.05).
Chhabra et al, 2016[11]	India	Children diagnosed with congenital or rheumatic heart disease requiring cardiac surgery	Males 324 (62.4%), females 195 (37.6%)	• A slightly higher ratio of male to female patients was seen in urban areas when compared with the rural areas (1.71:1 in the urban setting and 1.64:1 in the rural setting, with a P value of 0.823).
Lin et al, 2017[12]	Republic of Congo	All patients presenting with a surgical condition	Males 725 (60.1%), females 482 (39.9%)	• Female sex was associated with higher odds of postoperative complication (OR 3.45).
Bohn et al, 2016[13]	Addis Ababa, Ethiopia	All paediatric patients aged 29 days to 14 years admitted via emergency or hospital ward	Males 4078 (59.4%), females 2788 (40.6%)	• The proportion of male admissions was significantly higher than female admissions in all age groups (p<0.0001).
Ahmad et al, 2015[14]	Pakistan	Patients aged >50 years from fishing communities in Kemari undergoing cataract surgery	Males 58 (40.0%), females 87 (60.0%)	• Women experienced substantially worse visual outcomes than men. • Compared with men, women were 4.38 times more likely to have borderline or poor visual outcome.
Tanchangya et al, 2015[15]	Bangladesh	All cataract surgery patients	Males 6513 (58.3%), females 4661(41.7%)	• The prevalence of cataract was higher in women than in men, indicating a greater need of treatment for women. Yet, more males than females received surgical treatment.
Segev et al, 2009[16]	United States of America	Patients on Medicare with end-stage renal disease requiring transplantation	-	• Women had 11% less access to transplantation than men.

OR: odds ratio.

among women.[12] For any given indication, female gender was associated with higher odds of postoperative complications than males (odds ratio [OR] 3.45).[12] This could be attributed to women presenting late with more advanced disease, impacting their prognoses. Compared to men, female patients had more delayed presentation (adjusted mean difference [AMD] 5.67 days, p=0.05), delayed surgical intervention (AMD 1.91 days, p=0.02), and prolonged length of hospital stay (AMD 1.67 days, p=0.05).[10] Women undergoing cataract surgery were also more likely to present late compared to men, translating into worse ophthalmologic complications.[14] In line with these implications and higher proportions of women in LMICs, recognising and rectifying these gender disparities is warranted.

Challenges and the way forward

Challenges experienced by women in access to quality surgical care can be

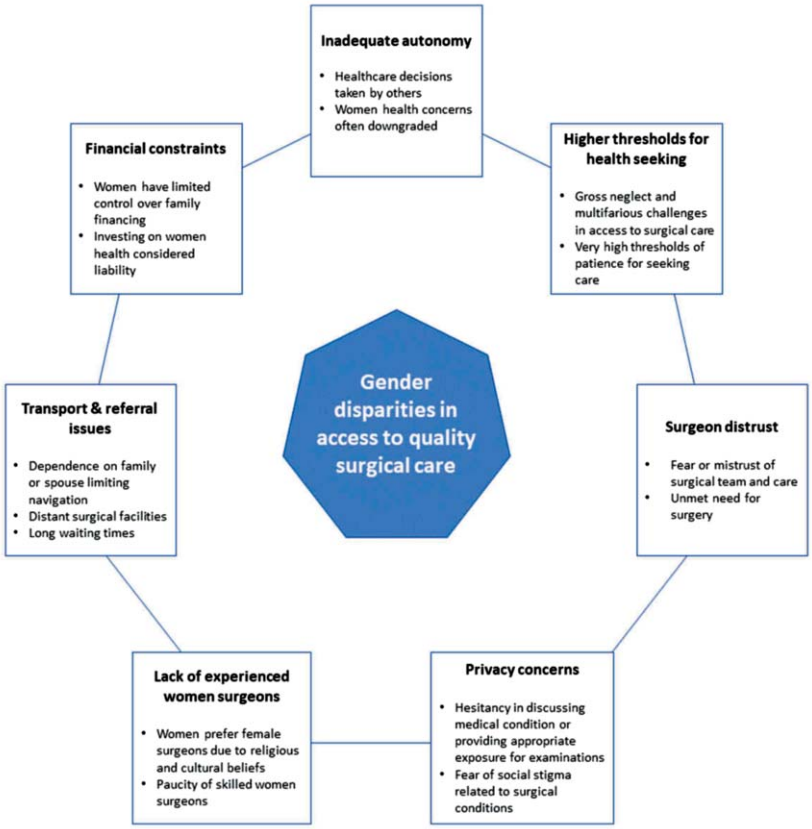

Figure: Mind-map of challenges faced by women seeking surgical care in resource-limited settings.

classified under the following domains: inadequate autonomy, financial constraints, transport and referral issues, lack of experienced women surgeons, privacy concerns, surgeon distrust, and higher thresholds for seeking care (Figure).

Inadequate autonomy: Gender-based differences in surgical care seeking stem from pre-existing sociocultural barriers.[18] In LMICs, women are often not equipped with adequate autonomy to take decisions regarding their own health. Instead, such decisions are mostly taken by the patient's husband, father, or mother-in-law.[19] In such cases, health concerns of women are often downgraded, and they present to hospital with advanced diseases, complicating their prognoses. This is further strengthened by evidence from India suggesting that women autonomous in their health decisions are more likely to seek care.[20] While direct evidence is limited, this scenario might be more pronounced in access to surgical care.

Autonomy in healthcare decisions has been associated with higher education, employment, exposure to media and awareness, and better household economic status.[21] Education continues to be a significant predictor of surgical care-seeking, owing to better awareness among women and increased financial stability to support their decisions.[20] Therefore, sustainable efforts targeted at educating and empowering women in LMICs can alleviate the gender disparities in surgical care. This can be achieved with a combination of both short-term solutions, such as implementing national distance learning programmes via radio, television and social media to educate women, and long-term solutions aimed at the establishment of schools particularly in rural and underprivileged areas.

Financial constraints: In most LMICs, financial implications of surgical care are borne through out-of-pocket expenditures.[22] This can disproportionately impact women, majority of whom are responsible for managing household only with limited control over family financing.[23] In addition, investing in women healthcare has traditionally been considered a liability due to longstanding gendered norms.[24] This situation necessitates the development of sustainable and efficient health financing initiatives by governmental regulatory bodies.[25] Monetary and logistical support from international community and health organisations can further improve the status quo for women requiring surgical care in LMICs. In addition, targeted efforts are required to increase job opportunities for women, making them more financially independent to take their own healthcare-related decisions.

Transport and referral issues: Another challenge faced by women seeking surgical care is navigating through the healthcare system. Because of their dependence on families or spouses, women usually require others to accompany them through the process. However, in cases of limited support from families, surgical care becomes more inaccessible for women, depriving them of timely surgical management.[24] Similar delays can also result from inefficient referral systems, which are widespread in LMICs. Compared to men, more women seeking surgical care reported long waiting times (22% vs 33%). In addition, distance to facilities capable of providing essential surgical care also impact women disproportionately (87% of women vs 81% of men).[24]

Such structural problems need to be addressed by expediting procedures at basic healthcare units and improving the infrastructure to provide better referral options.[26] Basic health units (BHUs) are often understaffed and require expansion of the existing healthcare force to be more efficient in providing timely referrals. To accompany women to surgical facilities, the authorities could employ non-healthcare personnel or establish volunteer services, which have proved successful in high-income countries (HICs).[24] In addition, women-only bus services can be introduced nationally to provide convenient, affordable, and secure transport options to women.

Lack of experienced women surgeons: As a result of religious and cultural beliefs, women often prefer female surgeons while seeking surgical care.[27] However, there is a paucity of skilled women surgeons in LMICs owing to an array of disparities faced by women surgeons.[28,29] First, the work environment is unfavourable for women with inadequate support for pregnancy and parenting, limited mentorship and sponsorship opportunities, widespread harassment, negative perceptions among the surgical community and patients, poor surgical identity, and limited opportunities for career advancement and leadership. Second, the surgical sphere is dominated by males, resulting in the exclusion of women from potential career development opportunities unless they conform to male standards. Lastly, women surgeons are hindered by societal pressures secondary to long-standing stereotypes and inordinate work-life expectations and conflicts.[29] Rectifying these disparities is imperative to incentivising more women to opt for surgical fields, which can in turn improve the health-seeking behaviour among women.

Privacy concerns: In various large-scale hospitals, a high turnover of patients may compromise privacy. This can contribute towards hesitancy among women in

discussing their medical condition or providing appropriate exposure for physical examination among multiple patients in the ward.[24] Providing privacy during consultations could reduce patient discomfort, while also allowing the surgeons to take more accurate histories. Obtaining informed consent before proceeding with physical examinations and appropriately covering the patients can further improve patient comfort and strengthen the patient-physician relationship. Women also reported of being afraid of social stigma related to their surgical condition.[24] This mandates that surgeons uphold the notion of doctor-patient confidentiality and ensure safeguarding of all hospital records to gain the confidence of their patients.[24] In addition, regular audits are required to investigate potential breaches of doctor-patient confidentiality, and a zero-tolerance policy towards such breaches should be institutionalised.

Surgeon distrust: Another challenge contributing to the unmet need for surgery among women is surgeon distrust. Fear or mistrust of surgical care was reported by 42% of women seeking surgical care in Ghana.[24] Re-establishing surgeon-patient trust is imperative, and can be achieved with surgeons providing reassurance to patients, allowing them to ask questions, explaining their laboratory results, avoiding being judgmental of patients, and involving patients in decision-making related to their care.[30]

Higher thresholds for seeking care: In line with gross neglect and the various challenges highlighted, women have also developed very high thresholds of patience for seeking care.[31] Because of this, women often have delayed presentation with more advanced diseases compared to men, and are subsequently more likely to have poorer prognoses.[10]

Conclusion

Women seeking surgical care are burdened with significant gender disparities, particularly in LMICs. While research has revealed the underlying causes of these disparities, much work remains for governmental healthcare bodies, the international community, surgical leadership, policymakers, and the family members of patients to act on the highlighted issues. Appropriate policies and programmes are necessary to ensure equitable delivery of surgical care for both genders, particularly in cases where differential surgical needs exist among men and women. Unrestricted access to quality surgical care for all is of vital importance, and such efforts can translate into a significant decrease in preventable disabilities and deaths among women in resource-constrained settings.

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LITERATURE REVIEW

Artificial intelligence in dentistry, orthodontics and Orthognathic surgery: A literature review

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Abstract

Artificial intelligence is the ability of machines to work like humans. The concept initially began with the advent of mathematical models which gave calculated outputs based on inputs fed into the system. This was later modified with the introduction of various algorithms which can either give output based on overall data analysis or by selection of information within previous data. It is steadily becoming a favoured mode of treatment due to its efficiency and ability to manage complex conditions in all specialities. In dentistry, artificial intelligence has also popularised over the past few decades. They have been found useful for diagnosis in restorative dentistry, oral pathology and oral surgery. In orthodontics, they have been utilised for diagnosis, assessment of treatment needs, cephalometrics, treatment planning and orthognathic surgeries etc. The current literature review was planned to highlight the uses of artificial intelligence in dentistry, specifically in orthodontics and orthognathic surgery.

Keywords: Artificial intelligence, Dentistry, Orthodontics, Orthognathic surgery, Diagnosis.

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Introduction

Artificial intelligence (AI) has been defined as the ability of a computer to perform tasks intelligently, equivalent to a human being, incorporating understanding and processing language with reasoning skills and problem-solving ability. AI can be sub-classified into fields like machine learning (ML), cognitive computing, deep learning, natural language processing, fuzzy logic, robotics, and expert systems.[1] ML is a part of AI whereby algorithms are used to predict outcomes by machines without the need of human input. Another part of AI is the neural networks that are designed like the interconnecting neurons of the brain and these algorithms mimic the brain function. In deep learning, different computational neural network (CNN) layers are utilised which can analyse the data input. These are also referred to as convolutional neural networks.[2]

Artificial intelligence in dentistry: AI has been used in dentistry for a very long time now, but the knowledge and awareness of dentists regarding AI is questionable. Abouzeid et al.[3] conducted a cross-sectional study to assess the knowledge, attitude and perception of dentists towards robotics and AI. The study sample consisted of dental students, graduates/interns, and postgraduate residents. Overall, there was limited knowledge (58.3%) regarding AI, but the attitude was positive (67.4%) as the study group showed high willingness to treat (83.3%) and recommend treatment (84.5%) with these modalities. While a general lack of awareness is seen, it is notable that the level of motivation towards the learning of AI and robotics is high. Hence, reforms in dental education should be considered where early learning of AI is incorporated into the system. In a systematic review by Ahmed et al.,[1] it was found that AI is a multi-disciplinary, multi-functional and multi-purpose tool that can be effectively used for precise, accurate and improved patient care by the treating dentists. It enables the prediction of expected outcomes and allows the exploration of possible treatment outcomes. This is in accordance with a study by Chen et al.[4] which found AI to be a comprehensive system that can not only provide high-quality patient care, but can also be used for innovations in research and development. Its most important feature is that it allows effective communication between healthcare providers in the form of "instant information exchange". Revilla-Leon et al.[5] conducted a systematic review to identify the effectiveness of AI in different presenting complaints of patients in restorative dentistry. The accuracy in the diagnosis of caries was found to be 76-88.3%, while the prediction of caries was 83.6-97.1%. The AI had 88.3-95.7% accuracy in diagnosing vertical fracture of the tooth, while the finishing line accuracy ranged 90.6-97.4%. The study concluded that AI is a "powerful tool for diagnosing caries, vertical root fracture, detecting tooth preparation

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margins, and predicting restoration failure". Limitations in the number of original research work has been recognised in these systematic reviews and further studies are still needed for better in-depth understanding of the technology.

Baliga[6] in his commentary highlighted the importance of AI in paediatric dentistry. With the introduction of four-dimensional (4D) goggles, movies, animations and virtual reality-based games, digital technology can now be effectively used for behaviour modification in children through more playful interactions. These advantages are also extended into a pedagogical environment for interactive teaching and learning through virtual simulations.

Grischke et al.[7] in their systematic review, which included 41 articles on ML, 53 articles on AI, and 49 original research on robotics, discussed the benefits of robotic tooth brushing and reported that "dentronics" will enhance reliability, reproducibility, accuracy and efficiency with a better understanding of disease pathogenesis. They found it to be an important tool for risk assessment strategies, diagnosis, disease prediction and better treatment outcomes.

Revilla-Leon et al.,[5] in their systematic review, assessed the applications of AI in implant dentistry by evaluating their recognition of implant success, type, design, optimisation and success prediction. They reported accuracy for the type using periapical radiograph and orthopantomogram to be around 93.8-98%, and the recognition of success rate to be around 62.4-80.5%. They, therefore, concluded that there was a great potential in AI for type recognition, recognition of success, prediction, design and optimisation in implant dentistry.

Hung et al.[8] reviewed ML algorithms to predict survival with oral cancer and the factors affecting it, and reported that extreme gradient-boosting ML algorithms showed the best performance with mean absolute error of 13.55, mean square error of 486.55 and root mean square error of 22.06. They concluded that cancer survival prediction and medical decision-making were possible with AI.

ML models have been applied to orthopantomograms for automatic tooth detection. They have also been utilised for Computer-aided design and Computer-aided manufacturing (CAD/CAM) and 3D printing for surgical guides and orthodontic brackets to predict extractions in orthodontic treatment planning etc, but they did not specify combinations of extractions using CNN. ML models can combine all the data for clinical decision-making. Other applications are landmark tracing, cervical vertebrae staging and skeletal classification.[9] CNN and artificial neural network (ANN) have been used for diagnosis in restorative dentistry, salivary gland disease, maxillary sinusitis, maxillofacial cysts, cervical lymph nodes, metastasis, osteoporosis, cancers and bone loss.[2]

Artificial intelligence in orthodontics: In the field of research in orthodontics, various advancements have been made utilising AI.

AI and orthodontic treatment need: Thanthornwong[10] utilised orthodontic impressions and facial photographs to evaluate orthodontic treatment need. The variables they used to construct the prediction model were missing teeth, overjet, overbite, anterior and posterior openbite, a diastema, anterior and posterior crossbite, anterior and posterior displacement, supernumerary teeth, ectopic eruption, anteroposterior molar relationship, and upper and lower lip to E-line. They had a sample size of 1,000 participants, and utilised 80% of the data as training data and created a prediction model which was then tested on 20% of the data which was called the test data. A sample of 20 patients was utilised to validate the data-sets. They constructed five models, of which the one with the highest level of specificity (100%), sensitivity (95%) and accuracy (96%) was chosen. Two orthodontists with more than five years of experience predicted the treatment need. Data of 200 patients was entered into the model which was calculated for treatment need using the model. The higher scores indicated treatment need, while lower scores indicated no treatment need. A high level of agreement was found when this network was validated (kappa value -1.00 with orthodontist A, kappa value -0.894 with orthodontist B). They concluded that the prediction model was an effective modality for the evaluation of treatment needs.

Wang et al.[11] evaluated the effects of treatment need through aesthetics using eye-tracking devices. Eye-tracking devices use anthropometric landmarks to determine the responses for areas of interest, which were the eyes, mouth and nose. The study sample consisted of 88 subjects who were shown pictures of normal individuals along with pre- and post-treatment ones in smiling and repose views. The results of the eye tracking device were compared with mixed-effect linear regression and support vector machine (SVM). SVM was further compared using Index of Orthodontic Treatment Need-Aesthetic Component (IOTN-AC) for the evaluation of accuracy of treatment need and outcome. The mouth

was highlighted as the area of interest in smiling photographs for normal, pre- and post-orthodontic treatment. SVM was found to be highly accurate in identifying treatment needs between normal and pre-treatment photographs (97.2%) and for treatment outcomes between pre- and post-treatment (93.4%).

AI in orthodontic diagnosis: AI has been extensively explored for effective and efficient diagnosis as well as patient care. Bichu et al.,[12] in their scoping review of 62 shortlisted articles, found that 33 articles emphasised the use of AI for diagnosis and treatment planning. CNN and ANN have been utilised for extraction prediction, orthodontic treatment need, cephalometric analysis, and age and gender discrimination. Neural networks have a role to play in diagnostic interpretations utilising computed tomography (CT), cone-beam computed tomography (CBCT), lateral cephalograms, bitewing, facial photographs and orthopantomograms.[2]

Kok et al.[13] used different algorithms to determine their accuracy in the assessment of cervical vertebrae maturation through the Lamparski method. The data was obtained from 300 cephalograms. They found an accuracy rate in the range of 78.7-93% for cervical vertebral maturational stage 1(CVS 1) with the highest being for ANN (93%), {k-nearest neighbours [k-NN] (78.7%), Naïve Bayes [NB] (92.1%), SVM (84.8%), random forest [RF] (91.8%)}. Decision tree (DT) gave the highest accuracy for the determination of vertebral body shape at 97.1%. Amasya et al.[14] measured data on 498 cephalograms for cervical vertebral maturation (CVM) staging using ANN (kappa score - 0.926), SVM (kappa score - 0.874), RF (kappa score - 0.908) and DT (kappa score - 0.921).

Cephalometric analysis: Numerous studies have been conducted in the past few years which have focussed on assessments of lateral cephalograms. The main focus has been on the accuracy of "automated landmark location" before conducting the actual analysis. Kim et al.,[15,16] using CNN on lateral cephalograms and CBCT for posterior-anterior cephalometric landmark tracing, found a high level of accuracy (88.43%, 80.4%). An error of 2mm, however, was reported for landmark identification for Postero-anterior (PA) cephalograms, but overall results were satisfactory.

A higher level of landmark identification was obtained when CNN was modified using an algorithm for "biomedical image segmentation" called U-Net.[17] The level of accuracy achieved was 92%. Dobratulin et al.[17] concluded that the results obtained were similar to landmark identification by a group of orthodontists. Lee et al.,[18] using the Bayesian Convolutional Neural Networks (BCNN)BN, found a 90.11% level of accuracy. We believe that accurate landmark location and identification are imperative in conducting an accurate cephalometric analysis. This was determined by Shin et al.[19] who conducted a study on 840 lateral and frontal cephalograms to predict the need for orthognathic surgery on skeletal malocclusion using a recurrent neural network (RNN) algorithm. The algorithm uses sequential data input which is stored in its internal memory. Sequential data input requires that all information be introduced in a sequence of steps. These steps are then followed for the assessment of new data incorporated into the system. A high level of accuracy (95.4%) was obtained with this system for the assessment of patients requiring orthognathic surgeries.

Recently, AI has been used specifically for cephalometric analyses. Silva et al.[20] used CEFBOT (RadioMemory Ltd., Belo Horizonte, Brazil), an AI-based cephalometry software, to measure 30 lateral cephalograms using Arnett's analysis. CEFBOT successfully performed measurements in 9/10 variables. The measured variables were re-evaluated after 15 days and correlated with human findings. Repeated measures of CEFBOT gave a high-reliability level (Intra-class correlation [ICC] >0.94) and they were not statistically different from the human findings.

AI in orthodontic treatment planning: The interest in AI for orthodontic treatment plans and outcomes has gained gradual interest with time. Earlier works consisted of the construction of mathematical models which could correctly identify patients in need of extractions. Takada et al.[21] and Yagi et al.[22] conducted a two-part research where they configured a mathematical model which could tell the need for and the desired pattern of extractions for a case. It was developed with the purpose of projecting an unexpected treatment outcome with extractions and to correctly identify the traits which led to the model's decision-making for choosing extractions. The input data consisted of patients' standardised photographs, radiographs and orthodontic casts. The model would identify features of presenting malocclusion and place it next to the nearest template already in the system. Multiple decisions were taken depending on the traits of the case. An overall computation of the outcomes was done before the final result was given. The accuracy of the model was tested against the decisions of the clinicians and an accuracy rate of 90.4% was obtained. The traits leading to

extraction decisions were overjet and upper and lower arch length discrepancy. The model created was modified and tested to determine extraction patterns versus clinicians. An accuracy of 86% was obtained with correction of incisor inclination and overjet and overbite as the causes for extractions. The model was further evolved by Xie et al.[23] using ANN. The model was tested for its ability to differentiate between extraction and non-extraction cases along with possible causes for extractions. The model had 80% accuracy in identifying extraction patients aged 11-15 years. The factors responsible for extraction were incompetent lips and proclined lower incisors.

Different programmes have been tested to determine their accuracy for extraction/non-extraction decision-making. Jung and Kim.[24] used the language R programme for the machine model to create a programme which could correctly identify extractions patients. The model was further tested for its ability to detect identical and differential extraction patterns based on 5 treatment plan groups which had been built into the system. The model was compared with the clinical plans of an experienced orthodontist. The model achieved an accuracy of 93% in identifying patients needing extractions with overall 84% accuracy in the extraction plan.

The advancement in AI has led to the emergence of different programmes. Li et al.[25] compared ANN with k-NN. Their neural network showed 94% accuracy of prediction of extraction versus non-extraction treatment. They also reported the accuracy of anchorage patterns to be around 92.8%. They found curve of Spee, angle ANB (angle formed between point A [point of deepest convexity on the labial cortical plate of the maxilla above the maxillary central incisor], nasion and point B [point of of deepest convexity on the labial cortical plate of the mandible below the mandibular central incisor]) and crowding in the upper arch to be the most important features for prediction of their neural networks.

Over the years, orthodontic record-keeping has become more technologically advanced as dynamic records of patients are more preferred than the traditional static forms. Tanikawa and Yamashiro[26] explored the possibility of an AI system that could be used by stereophotogrammetry to differentiate between extraction and orthognathic surgery cases. The model was constructed using landmark-based geometric morphometric methods (GMMs), and ML and two AI systems were developed. Data of a presenting case would be collected using anthropometric landmarks of the face and compared with the data of the previous patients already in the system. The systems showed a success rate of 54% for surgical and 98% for extraction cases at a system error of <1mm. However, when the system error was at <2mm, a success rate of 100% was achieved.

Artificial intelligence in orthognathic surgery: With the continuing advancements in technology, AI has been extensively explored in the field of surgery, ranging from ophthalmology[27] and spinal surgery[28] to knee arthroplasty.[29] Benefits include complex movements over shorter periods with high levels of precision.[30]

The preparation of patients requiring orthognathic surgeries can become a long and tedious procedure combining clinical and laboratory work. The traditional methods require the fabrication of acrylic splints which are used by surgeons as intraoperative guides. This is prone to errors as materials used undergo dimensional changes due to inherent properties or may fracture due to pressure. To overcome these limitations, Woo et al.[31] devised a surgical set of robotic arms which transferred information from the virtual screen to the operating room. The robotic arm was primarily designed to facilitate the surgeons during the procedure. The robotic arm could undergo movements at 6 degrees. On-screen movements centred on specific points were called tool centre points. These were located on a virtual simulation of the maxillomandibular complex around which axis movements were done. Overall, highly accurate and predictable movements of the jawbones were produced. Despite the advantages, Grischke et al.[7] found these procedures high in cost.

Mandibular surgeries are often associated with shifting of the condylar heads during repositioning of the segments. They can lead to the development of condylar sags post-surgically. To overcome these limitations, Lee et al.[32] devised an electromagnetic tracker device that could record movements of the condylar heads real-time. Other benefits included 3D coronal and sagittal views to ascertain the position of the condylar heads in the fossa.

AI has also been explored for the creation of surgical splints. Elnagar et al.[33] in their research developed a 3D diagnostic model for diagnosis and a virtual orthodontic-orthognathic treatment plan. The model was fabricated using scanning and CBCT images which were combined to form a single model. The outcome led to the fabrication of a 3D splint using 3D printing as an intraoperative guide for the surgeons.

Ethical concerns with AI: With the emerging trend of using AI, a matter of ethical concern has also been raised. Mörch et al.[34] found 45 ethical issues with the use of AI in dentistry. These revolved around six principles of ethics, namely, prudence (concerned with deliberating well about what is good and advantageous to oneself, others, and life as a whole), equity (social justice or fairness), privacy (shielding one's personal life from unwanted scrutiny), responsibility (the ability to recognise, interpret and act upon multiple principles and values according to the standards within a given field and/or context), democratic participation, and, solidarity (voluntary union or fellowship amongst people). With the quick acceptance of AI in dentistry, it has become imperative that recommendations be developed and brought into effect to overcome the ethical concerns recognised.

Conclusion

AI is a rapidly advancing modality in orthodontics which is enhancing patient care and management. It allows clinicians precision and accuracy in patient care. There is a substantive opportunity for AI to be utilised in the field of dentistry However, the ethical aspects must be taken into account as machines and computing systems cannot replace empathic human nature. Further research is still recommended to warrant its use in everyday dentistry.

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OPINION

Barriers in surgical research: A perspective from the developing world

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Abstract

Research in surgery has led to significant advances over the last century in terms of how medicine is practised in and outside the operating rooms today. Surgical research in the developed countries is responsible for most of this advancement, but it is often inapplicable in resource-limited settings in the developing world. Lower- and middle-income countries are in a unique position to take this work further, but they are limited by certain barriers. These barriers could broadly be classified under social and cultural, infrastructure, financial, ethical, and personal categories. These barriers are often not fully realised, but can potentially be addressed with concerted efforts to continue the advancement of medicine for everyone.

Keywords: Surgical research, Cultural barriers, Infrastructure, Limitations, LMICs.

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Introduction

Evidence-based practice is a cornerstone of efforts to improve the quality of healthcare the practitioners provide. The practice relies on integrating evidence acquired through research into patient preferences, resources and clinician skills. It is often easier said than done, with authors suggesting a global disparity between available literature and its translation into eventual clinical practice still not being up to par.[1-3] Surgical research faces some uniquely inherent obstacles, which differ from studies into pharmaceutical and medical treatments.[4,5] Matters like a surgeon's expertise and personal preferences in procedure or technique, lack of interest of patients towards participation, and the variation in skill level of the operating surgeon may all contribute to underpowering of studies, like randomised controlled trials (RCTs), with potentially misleading results.[5-7]

This issue aside, it must be emphasised that though global standards tend to encourage implementation of more standardised recommendations, these may not always be viable alternatives in the developing world due to geopolitical or cultural limitations, amongst other reasons. In such a case, it is critical for practitioners and researchers to generate evidence which is better suited to their demands and applicable within the limitations they face.

It goes without saying that improvement in the overall standards in study design and control of potential obstacles may aid in improving the quality of research,[7] especially from those originating in the developing world. The current narrative review was planned to explore the potential barriers faced in surgical research, particularly in the context of low- and middle-income countries (LMICs).

Social and cultural barriers: In LMICs, probably one of the most important barriers to conduct surgical research is the social and cultural behaviour. Unfortunately, and contrary to common belief, this is not limited to patients only, as studies have cited various reasons for the healthcare providers (HCPs) not participating in research-related activities,[8] imparting a negative influence on the overall research process. Globally, and particularly in LMICs, there is a general reluctance on the part of patients to participate in research. Partly this has to do with the historical mishaps, like the Tuskegee study, the infamous syphilis study where even after knowing that penicillin would be effective for syphilis, it was not prescribed to the subjects for the sake of experimentation and continuity of research.[9] Another example from the horrors of the past includes a study at the University of Cincinnati where late-stage cancer patients, for the sake of understanding its effects, were exposed to high-dose radiation, and the subjects were told that it was the final attempt to arrest disease progression.[10] Later, the investigators admitted their inability to take adequate informed consent, and compensations were handed out to the families of the patients.[11] Besides the effects of such events, lack of education also negatively impacts the participation in research projects and therefore the ultimate impact of research on future generations. Patients and their families consider becoming a part of any research similar to subjecting themselves to a larger learning experiment. Many diseases are seen as a taboo in these societies and there is great reluctance to even seek treatment for these, let alone getting involved in research. Mental health, genitourinary, perianal and breast conditions for women are few of these to name.[12,13] This combination of lack of

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education and certain religious beliefs, ranging from considering ailments as punishment from the Divine to stopping the treatment and relying solely on prayers, results in patients avoiding treatment or seeking alternative ways of treatment for their diseases. Furthermore, in LMICs, due to lack of governing bodies and accountability or their dysfunctional presence, a variety of treatment modalities are often seen offered by individuals who are not experts in these fields, and the practice continues to flourish due to lack of awareness.[14] The growth of alternative medicine has further increased the options that patients prefer to utilise before contemplating any surgical procedure.[15,16] Many surgical pathologies are managed with a wide array of treatment modalities prior to surgery, adding multiple unmeasurable confounders for a research project aimed at studying surgical management as an intervention. There is significant heterogeneity in such cultural and alternative pre-treatments sought by the patients, making it impossible to adjust statistically in a retrospective study or in the power of a prospective trial.

The disconnect between patients and healthcare staff is even more significant in rural areas of countries like Pakistan. The intentions of practising physicians and surgeons are sometimes questionable. Thoughts of doctors prioritising private practice and performing unindicated procedures for financial gains are deeply rooted in these societies.[17] The study comprising two rural districts of Pakistan found many physicians doing unindicated Caesarean Section (CS) because of financial incentives. This further minimises patients' trust in their HCP and translates into their hesitancy to join any research.[17] Even in situations where patients do initially get enrolled in studies, there is a significant proportion of population that is lost to follow-up as patients fail to realise the importance of these studies and their responsibility in making them a success. This again is multifactorial as there are situations where they just do not feel obligated to comply since it does not involve monetary, medical or personal incentives. Furthermore, it is often financially burdensome, making it difficult for them to travel from rural to urban areas to attend follow-up visits[18] or for research-related activities. Many population-based studies do anticipate this issue and address it either by making the research team go to patient's doorstep or providing adequate monetary support for travels.

Lastly, there is a general lack of interest in research both on the part of patients as well as HCPs. The inability to train the residents in research-related activities leads to general lack of interest among the trainees.[19] Limited internet facilities, non-existent concept of surgeon-scientist, inability to identify relevant research questions, paucity of allocated research time, no financial support and lack of mentorship are a few of the factors that eventually lead to this concept of research being a 'waste of time' for undergraduates[19] and postgraduate students.[20,21] Unfortunately, when these young doctors become attending surgeons, their interest in surgical research is driven mostly by the requirements of career progression and promotions or sometimes due to motivation from the pharmaceutical industry.[22] In LMICs, most career progressions and promotions are linked to the number of publications rather than the quality of research work.[23] This quest for going after numbers rather than the essence of research inquiry, results in selecting already addressed and learned topics with very little emphasis on exploring new knowledge frontiers. There is no doubt that acquiring the art of surgical skill is a tedious process involving lifelong struggle for the surgeons, so there is always a tendency to view their own anecdotal experiences as standard of treatment, rather than utilising evidence-based medicine (EBM). A questionnaire-based study[24] reported that surgeons depend most on their own judgment and confidence and least on clinical practice guideline. Hindrance to do surgical research may have many other causative factors, but cultural and social barriers probably are not just important ones, but are also difficult to modify, as they involve both the patients and the surgeons. For any meaningful research to be done, it is probably of utmost importance to deal with these barriers. Inclusion of quality research training during undergraduate and postgraduate surgical training can be a potential solution to some of the above-mentioned issues. But, more importantly, fostering the careers of young trainees as young research-scientists by means of allocating protected facilities, commitment and becoming part of different surgical research groups, though sounding like a long road, can eventually be fruitful. Crossing these hurdles will take time and collective efforts are needed to get over them one at a time.

Infrastructure barriers: For the uninitiated, research can be a daunting task best left alone. Even under the best of circumstances and even with unlimited funding, research is challenging. Research often requires a deep understanding of methodology, statistics and institution-specific logistics. So why take part in it? Because the payoff offers a chance to change practice and improve outcomes. There is almost no research training in the undergraduate years of education, unlike countries where research productivity is high and research training starts as early as high-school, and undergraduate students get

to spend considerable time in laboratories developing basic research skills and grantsmanship. Possibly the biggest challenge to surgical research in Pakistan and other resource-poor countries is lack of effective training during the formative years of a medical professional.

Since the Pakistan Medical Council (PMC) has not made research training mandatory for medical students, the onus shifts to medical colleges and universities to decide the status of research in their respective curricula. Even under the most well-designed and holistic medical curriculum in the country, research is often allotted 1-2 months during the 5 years of medical education; a period often structured to teach basic statistical skills and to churn out a qualitative study. These strategies, while effective for a minority of the students, often lack the intentionality to drive home the simple inspiring concept behind research: to question the norm.

With the faculty seeking to publish to meet requirements set out by the PMC and the Higher Education Commission (HEC), a preponderance of un-indexed journals, and a culture in which research is a 'means to an end', research transforms into a robotic task akin to administrative paperwork. Perhaps a curriculum that promotes critical thinking, teachers who promote a questioning mind, and a system that enjoys being proven wrong for the sake of progress can together lead to a shift in the mindset and, therefore, culture. Student-led journal clubs can, for instance, encourage an appreciation of the impact of research. Not only can this inspire students, but also help them critically appraise literature; skills that they can then employ during their faculty years.[25]

All this having been said, it is also important to address one of the biggest challenges to research is the lack of opportunities to disseminate and share knowledge.[26] If one were to draw comparisons with resource-rich nations and review the legacy of research institutions, a clear conclusion would take shape: the reason why research impact is high in these nations is because research exists in a self-perpetuating ecosystem and entire separate ecosystems have been created to support it. Put simply, research is not simply an activity, but a calling, a lifestyle and a profession. It is also important to note that this system simply cannot exist without a common belief in the power of research.[26,27] If one were to open Google Scholar, one would see the following text on the main page: 'Stand on the Shoulder of giants', This sentiment is only possible if one can find these 'giants', locate their 'shoulders', and know how to 'stand on them'. It is, therefore, in the interest of countries like Pakistan to celebrate their researchers, highlight their work, invest in the scientific process, and champion change as suggested by the scientific process. It also goes without saying that investment in physical infrastructure like internet, workspace, libraries etc., as well as human infrastructure, like capacity development, training programmes, research implementation workshops etc., will act as a catalyst of change in the research world.

Financial barriers: When it comes to funding research, the financial barriers in Pakistan are huge. It goes without saying that a lot of research in resource-rich nations would not have been impossible without federal funding and private endowments. Some efforts have been made in Pakistan to establish a funding stream for researchers. The development of the Pakistan Medical Research Council (PMRC) was one such step.[28,29] Under the PMRC funding for research as well as research allowances were allocated in the budget. Unfortunately, political forces, budgetary issues, poor utilisation of funds, and a lack of planning have limited the scope of such programmes.[28] Compared to research institutions, like those in the United States, with their many funding options, a methodical approach to spending research dollars, a preponderance of oversight boards, and a well-trained research staff, research in poor countries lack expertise in these key areas. At some level, the narrative turns into one in which money spent on research is money that could have been conserved for other endeavours, such as increasing health delivery in extremely resource-poor areas of the country. However, the country stands to benefit from advances in research, especially when such research is specific to the local community.[30]

Ethical barriers: A major hallmark of conducting ethical research is ensuring that there is oversight in the form of a review board, legislative oversight from national bodies, equal representation, and a clear emphasis on the principles of patient care. A well-informed and well-staffed institutional review board is of paramount importance when it comes to ensuring ethical standards. Additionally, ethical frameworks also need to be informed by national medical bodies. At baseline, all research studies, regardless of their design, should be proposed to the ethics board for protocol review. This should also hold true for retrospective studies, arguably the most common form of published surgical research, to ensure that patient privacy is always a priority, and that the results are useful. Additionally, when it comes to interventional studies, it is very important to always question the short- and long-term benefits of evaluating the intervention. This framework of thought also helps prevent unnecessary research, as McDonald et al, so aptly asked: 'When is further research no longer required; that is, what constitutes sufficient evidence of the efficacy of a surgical intervention?.[31] Routine expert panels, even in the

absence of expensive RCTs, can often help reach consensus statements, thereby obviating the need for further study.

The role of industry funding is important to discuss, especially in the context of developing nations. Given the limited resources provided by national bodies, a natural dependence on private endowments and industry funding emerges. As the role of industry increases in surgical research, so too should awareness increase around declaring conflicts of interest. Many studies have found associations between reporting positive findings and receiving royalties.[32] Mechanisms to reduce the influence of these conflicts on the integrity of research should be built into the very fabric of the institutional review process so as provide insight to any biases that may exist.

Personal barriers: It goes without saying that scientific research is a fundamental cog in the development of societal constructs. Yet, ironically the two share an interesting, dichotomous relationship in the sense that without proper funding and infrastructure, loco-regional healthcare systems may lack the necessary ingredients for the propagation of meaningful literature. Differences in geopolitical structures and regional dynamics may influence healthcare priorities, which may dictate alternative routes of medical management, custom-tailored to those situations. That being said, even though institutional bodies may push for more standardised treatment and training options, due to regional limitations this may not always be ideal. In fact, often literary works conducted in developing countries are of undesirable quality compared to that from the developed world.[31] While commenting on the countries of South Asia,[34] make the point that despite the linguistic, cultural and geographical differences between the countries in and adjacent to the region, various healthcare systems face similar obstacles and limitations.

On review of literature produced on this topic from developing countries, one of the most common themes noticed was that of the variability of training in terms of research methodology. This has been found to have stemmed from clinical priorities being more focussed on providing healthcare than generating quality research, and may manifest in a myriad of ways. A common complaint had been the lack of dedicated research training, or inadequate knowledge on terminologies or means of how to gather data.[32-37] The authors of these studies found that a limited familiarity with research in general may be a key demotivating factor for physicians to embark on such endeavours. This has been found to run hand in hand with the lack of dedicated research facilities and resources, be it as basic as a library or access to recent medical literature.[32-35, 37]

Similarly, another key factor can be boiled down to 'time and money'. Given busy clinical schedules, and work demands, researchers may find little available time to pursue research activities or seek out help from mentors and supervisors.[34] Furthermore, lack of monetary incentive in most research projects has been found to be a key deterrent. Keeping in mind the financial situation of most of the countries in the developing world, it would be understandable for the practitioners to prefer clinical practice over scholarly work, especially given that they would have to sacrifice their own personal time to get the job done.[33]

Provided the limited dedicated training, and unavailability of time, a more relevant and common theme would be that of lack of appropriate mentorship. This issue may present itself either as clinical supervisors and senior faculty being unable to dedicate attention to their fellows due to heavy/busy schedules, and thereby may not exuberate interest in such projects.[35,38] There is thus a need for more positive role models and professionals at more dedicated research positions to alleviate this shortcoming and offer not only guidance but also counselling and statistical services. This matter is made worse by prolonged waiting times and complicated steps involved in institutional approval; a matter which often stems from institutional bureaucracy and policies.[34,35,37]

An issue often overlooked is that of linguistic limitations. Considering most data and literature is in the English language, and that practitioners and researchers in the region may not be dominant English users, they face the unique challenge of requiring translations and linguistic support from librarians and associated platforms. Interestingly, this has been a common theme spanning regions from Africa to South Asia.[33-35,38-40]

The most devastating of personal barriers to research, however, is the little explored entity of research anxiety, which can negatively influence productivity, and potentially lead to mental and physical exhaustion, burnout, and organisational and personal deterioration.[41,42] Stress and anxiety can take root at any stage of a given project, from personal skill levels or lack thereof, to institutional approval, perpetual deadlines, and to the uncertainty of the authenticity of their works.[42-44] Thus, institutional laws, policies, local facilities and basic knowhow play a vital role in this issue.[41] Lack of attention to such barriers may lead to irreparable losses in terms of overall quality, while, for the investigator it may

result in decreased job satisfaction and long-term psychological harm.

Conclusion

LMICs face certain barriers in terms of surgical research. These barriers can broadly be classified under social and cultural, infrastructure, financial, ethical, and personal categories. These barriers are often not fully realised, but can potentially be addressed with concerted efforts to continue the advancement of medicine for everyone. There may still be numerous barriers at the individual level, that are beyond the scope of this review. A multi-pronged systematic approach is needed to overcome these challenges. Organisational, financial and infrastructure barriers need both institutional and national commitment to research. This should not only include short-term steps, like funding, facilities, etc., but, more importantly, long-term policies, incentives and collaborative initiatives to make a meaningful impact. Research education and internship opportunities from at least the undergraduate level is key to fostering a culture, a mindset and eventually a habit in surgeons. Social, cultural and some ethical barriers, although difficult to modify, could be addressed with investments in population-wide education programmes and focussed awareness campaigns. These may be lofty ideas for an LMIC, but there is no better time to start investing in such initiatives than now. Having said that, some barriers are going to be insurmountable and something that we will learn to work with and others will require time to overcome.

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SHORT REPORT

Conceptual framework for a cardiac surgery simulation laboratory and competency-based curriculum in Pakistan — a short innovation report

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Abstract

Simulation is a commonly utilized technique in healthcare education as it provides trainees a realistic, but safe, environment to learn a variety of skills. Trainees belonging to fields known for high stakes with low margins for error, such as cardiac surgery, can greatly benefit from simulation-based education. We propose the establishment of the first multi-tier high fidelity cardiac surgery simulation lab with a structured curriculum that will eventually provide multidisciplinary training to promising cardiac surgeons across Pakistan. The simulation lab may also be used for research, grant acquisition and patent development. Our setup will include the following levels of simulation: a simple bench model, a virtual reality simulator and a unique human performance simulator. Our multitiered approach allows for appropriate sequential trainee skill progression. Finally, we hope that our model inspires the development of similar curricula and modules for trainees belonging to other surgical fields.

Keywords: Cardiac surgical procedures, Simulation training, High fidelity simulation training, Medical education.

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Introduction

With the advent of the 21st century, cross-cutting, innovative, and demonstration-based simulation has been established as a powerful tool for training health care providers.[1] The ubiquitous use of simulation for training healthcare providers in Advanced Cardiac and Basic Life Support (ACLS/BLS) is a testament to this paradigm's success.[2] The application of simulation in skill-based fields like surgery is even more significant, because not only does it allow greater standards of real-time training, but it also reduces the risk to patients who would otherwise be the first point of practice for new trainees.[3]

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This need is further pronounced in high-stakes, high-precision fields featuring a low-margin of error, like cardiac surgery.[4] High fidelity simulation (HFS) is still relatively nascent in cardiac surgery, owing to the challenges of setting up a tissue-based simulator of exceedingly complicated procedures. However, contemporary advances have not only made this possible, but also highly refined and developed.[5] The added aspects of intense research, interest by grant awarding bodies, and patent development aptly complement these advances.[6]

Precision-oriented simulation employed in cardiac surgery can pave the way for improved simulated training in healthcare sciences across the board. In this innovation report, we propose a concept note for a well-developed cardiac surgical simulation lab which would be complemented by the backbone of a carefully curated simulation curriculum. This initiative has the potential of becoming a groundbreaking advancement in medical training at both national and regional levels. In addition, the experience gained by developing such a complex simulation system will help push the frontiers of surgical simulation in Pakistan, and the lessons learnt will pave a pathway for other surgical fields to develop similar simulation systems.

Methods and Results

Primary Objective: The strategic establishment of a multi-tier, high fidelity cardiac surgery simulation lab, with a formal structured curriculum, would provide a platform for advanced multidisciplinary training at institutional, national, and regional levels.

Secondary Objective: Further concurrent and subsequent arms include curriculum development, research in simulation education, grant acquisition and patent development.

Modus Operandi: Three core principles lie at the center of a fully functional cardiac surgery simulation lab: it should be based on Evidence-Based Medicine, designed for comprehensive sequential training, and tiered with an appropriate progression of skills. This allows for a more cost-effective, trainee-specific approach instead of investing in a single high-fidelity simulation module alone. At the same time, our objective is to develop a resource-

agnostic comprehensive system that can integrate the already available resources in Pakistan, such as ACLS and Harvey manikins, with a newly developed simulator.

This concept note discusses the development of a novel cardiac surgery simulation lab in a low-middle income country like Pakistan, which would include the following three models:

1) Simple Bench Model (SBM): This is a low-cost instructive set up to be used in conjunction with locally sourced animal-based hearts or synthetic tissue e.g. The Chamberlain Group HeartCase.[7] This system is especially effective for instructing larger groups in surgical approaches and techniques. Similar systems, such as the animal hearts without simulation case, have already been piloted and have been run as wet labs by many institutions in Pakistan. The set up provides realistic challenges of texture, exposure, access, and suture angulation in the depth of the pericardial well that cannot be emulated with an animal heart alone. The versatile nature of the model will serve as a basic platform for cardiac surgery workshops held in future.

2) Virtual Reality Simulator: This system focuses on advanced, high-technology systems designed to simulate haemodynamic parameters in the safe environment of the simulator, as opposed to the operating room (OR) on a live patient. The systems are programmed with advanced algorithms that can be triggered to allow the simulation of regular scenarios as well as disaster scenarios. The objective is to create exposure to well-known, common complications associated with cardiac surgery and to inculcate the requisite reflexes in the safe environment of a simulation. This will improve the essential response and reaction times in real life situations by enhancing the overall training of the residents, and thus, improve patient outcomes and overall costs due to shorter OR time, similar to Califia 2 system by Biomed Simulation (U.S.A) and Orpheus (Australia).[8]

3) Human Performance Simulator: This apical tier for surgical trainers is represented by high fidelity simulators that allow near-complete simulation of the entire cardiac surgical procedure on a beating animal heart. These devices are animated by programmable pumps that can mimic most intraoperative scenarios which would require critical thinking from the trainee. These systems can allow practice of highly complex procedures such as: 1. Great vessel cannulation, 2. Coronary Artery Bypass Grafting, 3. Valve replacement and repair procedures, 4. Atrial/Ventricular Septal Defect repairs. The system can be used in conjunction with the Virtual Reality Simulator to emulate complete procedures, including hands-on surgical skills and appropriate responses to intraoperative complications. The best-known representative simulator is the Ramphal Simulator designed at the University of the West Indies and now utilized by major institutions across North America.[4]

Framework and Outcomes: Economic sustainability is a cornerstone to optimizing the development and upkeep of this simulation lab. Our tripartite strategy for long-term economic sustainability has been described in Figure-1. The United States-based Thoracic Surgery Directors

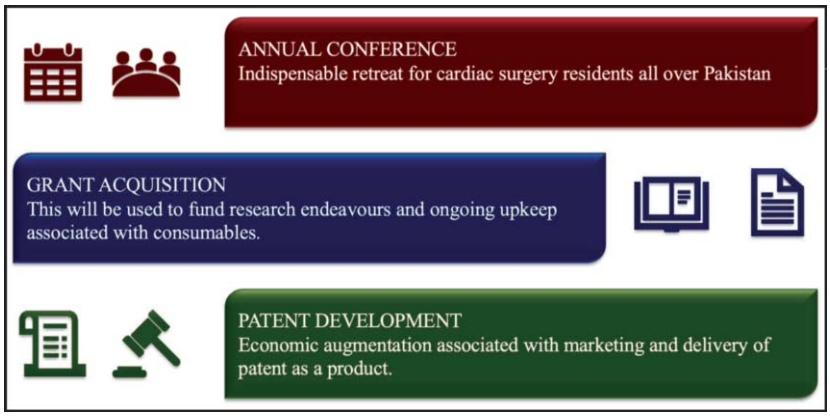

Figure: Overview of the trimodal strategy to provide economic sustainability for the cardiac simulation laboratory.

Table: Overarching framework of 12 curricular teaching modules and an annual cardiac surgical retreat.

	Curricular Teaching Module	Description
1.	Cardiopulmonary Bypass Module	Primary procedure module (Component 1 of 6)
2.	Ischaemic Heart Revascularization on pump plus off pump	Primary procedure module (Component 2 of 6)
3.	Aortic Valve Replacement	Primary procedure module (Component 3 of 6)
4.	Mitral Valve Repair plus Replacement	Primary procedure module (Component 4 of 6)
5.	Atrial Septal Defect/ Ventricular Septal Defect	Primary procedure module (Component 5 of 6)
6.	Aortic Aneurysm Module	Primary procedure module (Component 6 of 6)
7.	Massive Air Embolism Module	Advanced scenario module (Component 1 of 6)
8.	Acute Intraoperative Aortic Dissection Module	Advanced scenario module (Component 2 of 6)
9.	Sudden Deterioration in Cardiac Function Module	Advanced scenario module (Component 3 of 6)
10.	Minimally Invasive Valvular Surgery + Maze Procedure	Advanced scenario module (Component 4 of 6)
11.	Complex Multicomponent Surgery - Valve + CABG	Advanced scenario module (Component 5 of 6)
12.	Redo Cardiac Surgery	Advanced scenario module (Component 6 of 6)
13.	Annual Cardiac Surgical Retreat	7 Day condensed culmination of in-house curriculum for Cardiac Surgical Residents from all over Pakistan

Association (TSDA) 'boot camp' has already applied this three-tier system for the past few years to train Cardiac Surgery residents from the top institutions around the country.[9] However, given that the variability of centers across different settings also translates downstream to integral differences in resources and protocols, it is important to develop a home-grown and contextual curriculum for Pakistan. It is also imperative to keep surgeons at the forefront of designing such curricula. Details of our training curriculum framework have been provided in Table-1.

Given the dearth of such ventures on a global scale, and especially in low- and middle-income countries, there is a likelihood of attracting an international group of trainees and academicians as well. In this manner, there is also a potential to recover and even exceed the original investment utilized in the setting up of the lab. The lab would also serve as a valuable research source for the study of curriculum teaching in the highly complex field of Cardiac Surgical Education.

Conclusion

Cardiac Surgery is a high-precision, high-stakes, multidisciplinary field involving complex surgeries with very little room for error. Adequately training residents and other members of a cardiac surgery team in the safe environment of a high-fidelity simulation lab will improve their skill levels, leading to safer operations and shorter operative times in real life situations. Extensive training in cardiopulmonary bypass-related disaster situations, ubiquitously recognized as life threatening, will improve patient outcomes significantly.

Concurrently, it is paramount to establish Pakistan's first full-fledged simulated surgical curriculum simultaneously with the provision of adequate equipment and extensive training scenarios, including evaluation checklists and educational research. Future directions could be to pilot this at the intra-university level, as an annual high fidelity simulation course with a complete workshop curriculum for trainees at the national and international levels. Finally, the concept note for this innovative model can be used to extrapolate similar training modules in other fields of surgery.

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STUDENTS' CORNER
PILOT STUDY

Radial artery coronary bypass grafting: Surgical outcomes of an unexplored innovation in a developing country

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Abstract

Objective: To explore postoperative outcomes, particularly prolonged length of hospital stay, in radial artery coronary artery bypass graft patients in a tertiary-care setting.

Methods: The pilot prospective cohort study was conducted at the Aga Khan University Hospital, Karachi, from September 2019 to September 2020, and comprised adult patients of either gender due to undergo coronary artery bypass grafting for coronary artery disease involving two or more vessels. The subjects were approached for the use of their radial artery as a conduit. Prolonged length of hospital stay was defined as postoperative stay >9 days. Multivariable logistic regression was used to identify independent predictors of the length of hospital stay. Data was analysed using SPSS 21.

Results: Of the 97 patients, 84(86.6%) were males. The overall mean age of the sample was 58.33±8.34 years. Mean length of hospital stay was 8.10±2.37 days, and 23(23.7%) patients had prolonged stay. Higher age was a significant predictor of prolonged hospital stay ($p<0.05$). Besides, 23(23.7%) patients developed acute kidney injury. There was no incidence of wound, infection or deep venous thrombosis, while 1(1.03%) patient had to be reopened due to excessive postoperative bleeding, and it represented the lone mortality.

Conclusion: Patient age was found to be a significant predictor of prolonged hospital stay in patients undergoing radial artery coronary artery bypass graft, while almost a quarter of the sample was affected by acute kidney injury.

Keywords: Coronary artery bypass graft, Radial artery, Prolonged length of stay, Acute kidney injury, Ejection fraction. (JPMA 72: S-106 [Suppl. 1]; 2022)

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Introduction

The bypass vessel conduits most frequently used in coronary artery bypass grafting (CABG) are the left internal mammary artery (LIMA) and the greater saphenous vein (SVG), with the graft of LIMA to the left anterior descending (LAD) artery acknowledged as the gold standard.[1] However, grafts from the right internal mammary artery (RIMA) and the radial artery (RA) have also been used. Moreover, both arterial grafts have been found to have better long-term clinical benefit compared to the SVG, leading to recommendations in favour of RA as the preferred second conduit after LIMA in multi-vessel CABG.[2,3]

Despite the first use of a RA graft in 1973,[4] its use as the second-choice conduit has been limited in Pakistan in favour of the more conventional SVG. As such, scarce information is available on the surgical outcomes and risk factors associated with RA grafts in the Pakistani population. The use of RA as the second conduit is associated with shorter post-operative length of hospital stay (LOS) possibly due to the lower risk of harvest-site infection compared to the SVG.[5]

Prolonged length of post-operative hospital stay (PLOS) has been recognised as an important outcome, as it incurs increased hospital resource utilisation and higher patient costs. Although PLOS has been studied extensively in CABG procedures[6-8] overall, where the SVG is the most commonly chosen second conduit after LIMA, there is little research regarding PLOS in CABG procedures where the RA serves as the second-choice conduit. This is particularly the case in developing countries, such as Pakistan, where the additional cost and expenditure resulting from PLOS adds further burden to an already resource-constrained healthcare system.

The current study was planned to explore post-operative outcomes, in particular PLOS, and associated factors amongst patients undergoing CABG with RA grafting in a tertiary-care setting.

Patients and Methods

The pilot prospective cohort study was conducted at the

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Department of Cardiothoracic Surgery, Aga Khan University Hospital (AKUH), Karachi, from September 2019 to September 2020. After approval from the institutional ethics review board, all adult patients, both male and female, undergoing CABG for coronary artery disease involving two or more vessels were approached. Informed consent was taken from all patients whereby they agreed to the use of the RA as the second conduit along with LIMA in their CABG surgery. Patients who refused consent to RA harvest and those with an abnormal modified Allen's Test, with capillary refill taking >12 seconds, were excluded.[9] The RA graft was anastomosed to the right side of the coronary vasculature when the lesion in the right was >90% occlusive, and on the left side when the lesion in the left was >70% occlusive.

Data was collected from patients' charts and medical records through the online patient data system using a structured proforma which included patients' pre-operative, intra-operative and post-operative characteristics.

Ejection fraction (EF) was defined as the proportion of blood pumped out of the ventricles with each contraction, and the cut-off value was taken as 55%.[10]

Acute kidney injury (AKI) was diagnosed if any one of the three criteria were fulfilled: rise >0.3mg/dl in serum creatinine levels within 48 hours, or 1.5-fold rise in serum creatinine levels from baseline within seven days, and a reduction in urine output <0.5ml/kg/day for at least 6 hours.[11]

Body mass index (BMI) was categorised according to the World Health Organisation (WHO) ranges for adult Asians.[12]

There is no universally-prescribed cut-off value for PLOS has been described in literature. Thus, PLOS was defined as any post-operative hospital stay longer than the 75th percentile of the overall sample which was the equivalent of >9 days in our sample. The selection of this cut-off was agreed upon by the cardiothoracic surgeons and is consistent with other studies which use the 75th percentile to define PLOS after cardiac surgery.[8,13]

In terms of sample size calculation, it was hypothesised that 30% patients would experience PLOS. The hypothesis was made in the absence of previous studies exploring the incidence of PLOS after CABG using RA. The minimum sample size was calculated using OpenEpi calculator[14] with a finite population size of 300 cases, which is the annual volume of CABG procedures at AKUH, and 95% confidence level. As the current study was a pilot research, at least 50% of the required sample size of 156 was considered sufficient.

Data was analyzed using SPSS 21. For the comparison of data, independent sample t-tests and chi-squared tests were used, as appropriate. Subsets of the sample according to pre-existing hypertension (HTN) were also analysed. Univariable and multivariable regression analyses were performed. Factors with $p<0.25$ on univariate analysis were included in multivariable analysis. Odds ratios (OR) with 95% confidence interval (CI) were worked out. All possible associations of PLOS with pre-operative, intra-operative and post-operative independent variables were assessed. $P<0.05$ was considered statistically significant in all cases.

Results

Of the 97 patients, 84(86.6%) were males. The overall mean age of the sample was 58.33±8.34 years. There were 66(68%) patients categorised as obese. The most common co-morbid was HTN 72(74.2%). There were 81(83.5%) cases of triple-vessel CABG. In addition to RA and LIMA, the most commonly used vessel was SVG 93(95.9%). The most common sites of distal anastomosis of the RA graft were the posterior descending artery (PDA) 47(48.5%) and the obtuse marginal artery (OMA) 26 (26.8%).

Pacing wires (PWs) were used in 26(26.8%) cases. The mean length of stay in the cardiac intensive care unit (CICU) was 1.2±0.54 days, or 28.8±12.96 hours. There was no incidence of wound infection, chest infection, urinary tract infection (UTI) or deep venous thrombosis (DVT) in the sample. There was 1(1.03%) case that needed to be reopened due to excessive post-operative bleeding and it was the lone mortality in the cohort. Pre-operative, intra-operative, and postoperative characteristics are summarized in Table-1.

Mean LOS was 8.10±2.37 days, and 23(23.7%) patients had PLOS. The PLOS group had a significantly greater age at surgery 61.65±8.13 years compared to 57.30±8.18 years in 74(76.3%) patients who did not have PLOS ($p=0.028$). In addition, a significant association was also found between PLOS and the use of PWs, with 10(43.5%) of the PLOS patients having a PW compared to 16(21.6%) of non-PLOS patients ($p=0.039$).

Among the 72(74.2%) patients with HTN, the duration of mechanical ventilation was shorter in the PLOS group 6.13±4.88 hours compared to the non-PLOS group 9.48±7.69 hours ($p=0.042$).

There were 48(49.5%) patients with EF <55%. T2DM was

Table-1: Patient pre-operative, intra-operative and post-operative characteristics.

Variables N (%)	Total	Prolonged Length of Stay		P-Value
		Yes	No	
	97 (100)	23 (23.7)	74 (76.3)	
Age (Years)	58.33 ± 8.34	61.65 ± 8.13	57.30 ± 8.18	0.028
Gender				
Male	84 (86.6)	19 (82.6)	65 (87.8)	0.5
Female	13 (13.4)	4 (17.4)	9 (12.2)	
BMI (kg/m2)	27.81 ± 4.93	27.91 ± 4.56	27.77 ± 5.07	0.909
BMI Class				
Underweight	1 (1.0)	1 (4.3)	0 (0)	
Normal	12 (12.4)	1 (4.3)	11 (14.9)	
Overweight	18 (18.6)	3 (13.0)	15 (20.3)	0.182
Obesity I	36 (37.1)	11 (47.8)	25 (33.8)	
Obesity II	30 (30.9)	7 (30.4)	23 (31.1)	
EF < 55%	48 (49.5)	13 (56.5)	35 (47.3)	0.44
Present Comorbids				
HTN	72 (74.2)	16 (69.6)	56 (75.7)	0.558
T2DM	49 (50.5)	12 (52.2)	37 (50.0)	0.885
IHD	61 (62.9)	13 (56.5)	48 (64.9)	0.469
Smoker	23 (23.7)	6 (26.1)	17 (23.0)	0.759
COPD	3 (3.1)	2 (8.7)	1 (1.4)	0.139
Others	16 (16.5)	6 (26.1)	10 (13.5)	0.198
IABP				
Yes	2 (2.1)	2 (8.7)	0 (0)	0.054
No	95 (97.9)	21 (91.3)	74 (100)	
Surgery Duration (mins)	227.69 ± 61.97	251.87 ± 91.23	220.18 ± 47.96	0.112
Bypass				
Double Vessel	4 (4.1)	1 (4.3)	3 (4.1)	
Triple Vessel	81 (83.5)	19 (82.6)	62 (83.8)	0.991
Quadruple Vessel	12 (12.4)	3 (13.0)	9 (12.2)	
XCT (mins)	58.68 ± 16.39	63.39 ± 17.27	57.22 ± 15.95	0.115
CPBT (mins)	106.55 ± 28.69	110.87 ± 28.95	105.20 ± 28.68	0.411
Pacing Wire				
Yes	26 (26.8)	10 (43.5)	16 (21.6)	0.039
No	71 (73.2)	13 (56.5)	58 (78.4)	
Duration of Ventilation (Hours)	8.09 ± 6.62	6.87 ± 5.49	8.47 ± 6.93	0.313
CICU Stay (Days)	1.20 ± 0.54	1.41 ± 0.91	1.14 ± 0.34	0.161
Acute Kidney Injury (AKI)	23 (23.7)	8 (34.8)	15 (20.3)	0.153
Chest Tube Day 1 (ml)	542.00 ± 287.59	565.67 ± 164.16	536.08 ± 311.71	0.724
Chest Tube Day 2 (ml)	357.05 ± 242.20	487.35 ± 366.90	310.90 ± 160.43	0.071

BMI: Body mass index, EF: Ejection fraction, HTN: Hypertension, T2DM: Type 2 diabetes mellitus, IHD: ischaemic heart disease, COPD: Chronic obstructive pulmonary disease, XCT: Cross-clamp time. CPBT: Cardiopulmonary bypass time, CICU: Cardiac intensive care unit.

significantly more common (30/48 or 62.5% vs. 19/49 or 38.8%; p=0.019) and chest drain output in the first 48 post-operative hours was significantly higher (1038.53±450.13ml vs. 818.37±197.00 ml; p=0.007) in such patients.

Patients with ischaemic heart disease (IHD) had a significantly longer duration of ventilation 9.03± 7.5 hours than those without IHD 6.50±4.4 hours (p=0.039). Patients with HTN had a significantly longer duration of ventilation 8.74±7.3 hours than those not having HTN 6.24±3.8 hours (p=0.032). Among the HTN group, patients with EF <55% had a significantly higher post-operative creatinine 1.20±0.40mg/dL than those with EF >55% 1.04±0.19mg/dL (p=0.043).

Of the entire sample, 23(23.7%) patients developed AKI. The AKI group had a significantly higher pre-operative haemoglobin (Hb) 13.83±1.62mg/dL than the rest 13.06±1.39mg/dL (p=0.027), higher pre-operative creatinine 1.09±0.27mg/dL than the rest 0.93±0.22mg/dL (p=0.005) and post-operative day 1 (POD-1) creatinine 1.54±0.31mg/dL than the rest 0.98±0.19 (p<0.001). Patients in the AKI group also had a greater decrease in

Table-2: Univariable and multivariable regression analysis.

Variables	cOR (95% CI)	aOR (95% CI)
Age	1.076 (1.007-1.151) **	1.129 (1.010-1.263) **
Gender		
Male	0.658 (0.182-2.375)	
Female	Reference	
BMI (kg/m^2)	1.006 (0.915-1.106)	
Present Comorbids		
HTN	0.735 (0.261-2.068)	
T2DM	1.091 (0.428-2.783)	
IHD	0.704 (0.272-1.825)	
Ejection Fraction		
Normal	Reference	
Borderline	0.480 (0.98-2.342)	
Reduced	1.559 (0.417-5.828)	
Surgery Duration (mins)	1.008 (0.999-1.016) *	1.129 (0.989-1.015)
XCT (mins)	1.022 (0.994-1.051)	
CPBT (mins)	1.007 (0.991-1.024)	
Pacing Wire		
Yes	2.788 (1.033-7.527) **	2.901 (0.632-13.309)
No	Reference	Reference
Duration of Ventilation (Hours)	0.957 (0.878-1.043)	
CICU Stay (Days)	2.358 (0.906-6.144) *	2.134 (0.732-6.223)
Chest Tube Day 1 (ml)	1.000 (0.998-1.002)	
Chest Tube Day 2 (ml)	1.003 (1.0002-1.006) **	1.003 (0.999-1.006)

* $p < 0.25$. ** $p < 0.05$.
cOR: Crude odds ratio, aOR: Adjusted odds ratio, CI: Confidence interval, BMI: Body mass index, HTN: Hypertension, T2DM: Type 2 diabetes mellitus, IHD: ischaemic heart disease, COPD: Chronic obstructive pulmonary disease, XCT: Cross-clamp time, CPBT: Cardiopulmonary bypass time, CICU: Cardiac intensive care unit.

Hb post-operatively 3.82±1.59g/dL than the rest 3.15±1.46g/dL (p=0.063).

On univariate regression analysis with PLOS as the outcome, age, PW, and chest drain output on POD-2 were found to be significant predictors of development of PLOS along with surgery duration and duration of CICU stay (p<0.25). Only age remained a significant predictor of PLOS on multivariable analysis (p<0.05) (Figure). Older patients were significantly more likely to have PLOS (Table-2).

Discussion

The current study revealed overall favourable outcomes with the use of RA as a conduit in CABG. The incidence of PLOS and AKI (both 23.7%) represented the main sources of post-operative morbidity. Age was found to independently predict PLOS, while PW and chest drain output on POD-2 were significant predictors on univariable analysis.

Higher age has been found to be a predictor of PLOS post-CABG earlier as well.[7,15] The mean post-operative LOS in the current study was similar to an earlier study.[16] The mean age in the current study was lower than that what has been reported in most earlier studies,[17,18] while it matched the finding of a study conducted at AKUH in 2016. As age increases in adults, there is an increase in frailty and a decrease in physiological reserves, which comparatively retards their ability to recover post-operatively. The use of a PW has also been shown to lead to longer post-operative LOS.[19] Patients requiring a PW have been found to have a higher age, and a greater incidence of preoperative arrhythmias[20] and T2DM.[19] The percentage of patients in the current cohort requiring a PW was 26.8%, which is considerably higher than earlier reports.[8,18]

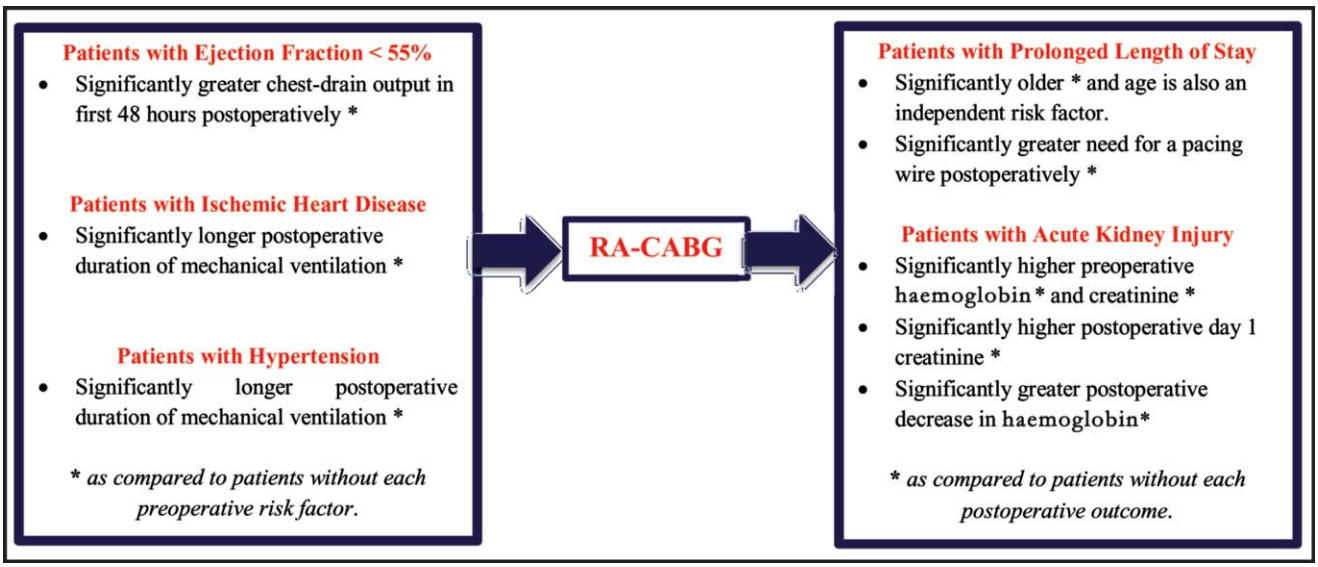

Figure: Pre-operative risk factors and post-operative outcomes.

The current results showed that patients who developed post-operative AKI had higher pre-operative serum creatinine and POD-1 creatinine along with higher pre-operative Hb. A raised pre-operative creatinine level may indicate a worse pre-operative renal function, or possibly background pre-existing chronic kidney disease (CKD).[21] Thus, developing AKI after CABG may be an exacerbation of it in the form of 'acute-on-chronic' kidney disease.[22] The POD-1 creatinine levels were also significantly higher in the group of patients who developed AKI. Even a minimal increase in creatinine early in the post-operative period can increase the risk of post-operative mortality.[23] Patients who developed AKI lost on average 3.82±1.59 g/dL of Hb compared to 3.15±1.46g/dL lost by patients who did not develop AKI. There are numerous studies having shown that increased peri-operative bleeding increases the risk of post-operative complications, including AKI.[24-26] Moreover, early post-operative decreases in Hb concentration are also strongly associated with AKI development.[27] Early identification and management of patients can help reduce the burden of AKI after RA-CABG. This includes pre-operative imaging of the genitourinary tract and the glomerular filtration rate (GFR) measurement, given the association of coronary artery disease (CAD) and CKD,[28] as well as optimising surgical techniques to decrease surgery duration and intra-operative blood-loss, and judicious use of nephrotoxic drugs, such as vancomycin, post-operatively.

Lower pre-operative EF (<55%) was associated with greater chest drain output over the first two PODs. This association has been demonstrated in a few prior studies where lower EF was associated with increased chest drain output,[29] excessive bleeding[30] and a higher risk of reoperation for excessive bleeding from the chest.[31,32] There was a significantly higher percentage of patients with T2DM in the EF <55% group compared to the EF >55% group. Patients with pre-existing T2DM and reduced EF represent a challenging population for CABG surgery due to the greater risk of post-operative complications,[33] including long-term mortality.[34] A study[35] showed that use of RA as the second-choice conduit instead of SVG conferred a late-survival advantage in diabetics undergoing CABG, supporting the use of the arterial conduit in this patient population.

A major limitation of the current study was its small sample size, resulting from a high rate of patient refusal for RA harvesting. Furthermore, this was a single-centre study, thereby its findings may not be generalisable. However, there is an absolute lack of research in developing countries regarding indicators, such as reduced pre-operative EF along with post-operative adverse outcomes, including PLOS and development of AKI associated with patients undergoing RA-CABG. Thus, the study can serve as the basis for future studies on the subject.

Conclusion

Although outcomes of RA-CABG were generally favourable, there were a few important associations, including patient age which was found to be a significant predictor of PLOS. Moreover, reduced EF was associated with greater post-operative chest tube drainage. Higher pre-operative creatinine and greater post-operative change in Hb were associated with AKI development.

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STUDENTS' CORNER
NARRATIVE REVIEW

The environment under the knife: A review of current Eco-surgical strategies and recommendations for Pakistan

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Abstract

The healthcare sector at its core is based on the fundamentals belief to do no harm and bring about betterment in the lives of the people. Paradoxically, hospitals are one of the leading contributors to pollution, greenhouse gas (GHG) emissions and toxic waste material worldwide. Surgical care delivery is quite resource intensive, consuming significant amount of energy and equipment as well as producing large quantities of waste. With climate change being a global priority, it is crucial that hospitals re-evaluate the environmental impact of such practices. The current review was planned to identify areas of improvement in surgical care in terms of sustainability, as well as describe efficient and innovative strategies for hospitals in Pakistan to lessen their impact on the environment. The implementation of the 5 R's strategy for surgical care (Reduce, Reuse, Recycle, Rethink and Research) as well as general measures to improve energy efficiency, waste management and inter-sectoral collaboration will provide significant benefits to the environment and advance efforts to creating a more sustainable future for surgical healthcare in Pakistan.

Keywords: General Surgery, Environmental Monitoring, Environmental health, Surgery Department, Hospital, Healthcare Delivery.

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Introduction

Healthcare institutions are amongst the leading contributors of waste products, even in a country as developed as the United States of America (USA) where they produce more than 4 billion pounds of waste each year.[1] Unsurprisingly, operating theatres and delivery rooms account for more than two-thirds of waste produced by hospitals, most of which is disposed through incineration or in landfills.[1] As safe-keepers of the health of humanity and responsible citizens of the world, it is the unquestionable responsibility of healthcare practitioners to commit towards reducing the disastrous environmental impact of the healthcare industry.

The term eco-surgery refers to the embodiment of an ecological approach to surgical healthcare,[2] which includes reducing energy consumption, using resources and raw materials judiciously, and decreasing environmental pollution.[1] The growing importance of eco-surgery is evident worldwide in the emergency of several global initiative to fulfill this purpose, such as the Green Guide for Healthcare[3] and Leadership in Energy and Environmental Design for Healthcare.[3] However, although institutions in developed countries such as USA have begun to take steps towards developing greener surgical practices,[1] developing countries like Pakistan have much ground to cover. Achieving environmentally sustainable surgical care on a global level requires urgent and focused commitment from countries across the world, including lower-middle-income countries (LMICs) like Pakistan. The added incentive to LMICs for achieving greener surgical practices is that this invariably comes with significant cost-savings.[1] Thus, aim of this review was to summarise current eco-surgical practices worldwide, with special focus on the role of hospitals in eco-surgery, and suggest initial recommendations to achieve an environmentally friendly surgical healthcare system in Pakistan.

Strategies to Negate Environmental Hazards: Several structural, behavioural, and procedural measures can reduce the deleterious effects of surgical procedures on the environment, and are discussed below with regards to the 5 R's strategy: Reduce, Reuse, Recycle, Rethink and Research[4,5] as summarized in Table-1.

Reduce: Every surgical procedure generates substantial amounts of waste, including surgical gowns, paper, masks, rubber gloves, and sutures, and judicious usage can lead to significantly significant reductions in waste. A "lean and green" surgical project in America resulted in 5.06 pounds lesser waste per operative case,[6] while a Hospital in the UK saved an incredible 19,000 kg of plastic

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Table-1: General Strategies to Combat Environmental Impact.

Reduce	• "Lean and green" surgical projects like in America[5]
	• Reducing consumption of plastic gloves
	• Reformulation of surgical kits[1]
	• Preventing over-supply of items[1]
	• Purchasing supplies from vendors who provide eco-friendly items[4]
	• Following international guidelines for PPE specific to each surgery
	• Reducing energy consumption by switching off surgical devices when not in use[1]
	• Implementing energy efficient heating, lighting, air-conditioning[4]
	• Gradual shift to renewable energy sources[3]
	• Promoting use of alcohol-based sanitizers instead of scrubbing when unnecessary[6]
	• Pedal devices operated by foot for scrubbing[3,7]
	• Scrubbing without using a brush reduces plastic waste[9]
Reuse	• Re-usage of surgical equipment by autoclaving[4]
	• Reusable sharp containers[4]
	• Using reusable items instead of disposable items like drapes or gowns[6]
Recycle	• Appropriate waste collection, transport, handling, segregation, and disposal[3,12]
Rethink	• Opting for one-stage surgical procedures which in the past have been done in two stages[6]
	• Alternative techniques for anaesthesia, instead of anaesthetic gases[12]
	• Use of broad-spectrum prophylactic antibiotics must be rethought[6]
	• Tele-consultation services to save travel and associated pollution from vehicles[1,3]
	• Medical documentation can be computerized for paperless records[3]
Research	• Evidence-based eco-surgical strategies and interventions[1]
	• Formation of interdisciplinary groups for regular audits
	• Educational and awareness programmes

in less than year by simply reducing consumption of plastic gloves. Manufacturers can be urged to reformulate surgical kits, such as for surgical equipment or protective gear, by removing unnecessary items and minimizing plastic usage.[4] Over-supply of items can be prevented by implementing regular audits evaluating demand and usage.[4] Moreover, orders should be placed only when items are needed in bulk, to reduce packaging, travel costs, and carbon emissions from transportation.[7] Importantly, hospitals should prefer purchasing supplies from vendors who provide eco-friendly items and operate eco-friendly businesses.[1] With regards to use of personal protective equipment (PPE), international guidelines should be followed specific to each procedure, rather than using all possible PPE for each surgery.

Reducing energy consumption is simple and beneficial. The simple measures of switching off ventilators and surgical equipment/devices when not in use, and ensuring appropriate regulation of temperature, resulted in a 2,000,000 kg annual decrease in carbon emissions across six hospitals in the UK.[4] In addition, implementing energy efficient heating, lighting, air-conditioning, sterilization, waste disposal, and infrastructural design can drastically reduce energy costs.[1] Moreover, a gradual shift to renewable energy sources, such as solar energy, would go a long way in achieving eco-friendly surgical practice in the future.[7]

Likewise, promoting use of alcohol-based sanitizers instead of hand washing or scrubbing when unnecessary, can help reduce water consumption.[2,4,5] NICE guidelines recommend that alcohol-based hand rubs be used for disinfection post-surgery if one's hands are only slightly dirty.[8] Moreover, pedal devices operated by foot save considerable amounts of water (only 6.7L per scrub),[2,7,9] and scrubbing without using a brush is also considered safe and reduces plastic and paper waste.[10] Education to surgeons and OR staff regarding appropriate eco-friendly measures to prevent surgical site infections have decreased water consumption by 2.7 million liters/year at a hospital in the US.[11]

Reuse: Re-usage of surgical equipment and re-processing of single use devices is still an area of utmost caution, due to the lack of standardized quality of autoclaving and other disinfecting methods. However, no increased health risk from the use of reprocessed devices has been reported so far,[1,12] and reprocessing reduces waste significantly but in addition to cutting costs.[1]

There are several items that can be safely reused, such as sharp bins, suture-packaging, and packaging and wrapping, all of which can help reduce waste significantly.[7] Reusable sharp containers reduce waste by approximately 34,000 pounds in a 1000-bed hospital.[1] Two hospitals in the US reduced waste by 23,000 kg/year by shifting to washable scrubs and reusable surgical gowns.[1,5] There is no benefit of using disposable items like drapes or gowns where reusable ones are available, as this can help tons of plastic.[2]

Recycle: A quarter of waste from surgeries and ORs can be recycled.[5] Often, hazardous/infectious and non-hazardous waste is not segregated, resulting in mass incineration and increased in emission of greenhouse gases.[4,7] Raising awareness and training staff for appropriate waste collection, transport, handling, segregation, and disposal is important to allow efficient recycling.[7,13] As per guidelines, health waste is segregated into 5 categories to allow for separate disposal and treatment: infectious (blood, vomitus, body fluids etc.), sharps (injections, needles etc.), radioactive, pharmaceutical and general non-hazardous waste (paper, gowns etc.).[1] However, general non-hazardous waste frequently ends up in the bag for infectious waste only, mostly due to a lack of awareness, leading to increased treatment costs and decreased recycling.[1]

Rethink: Re-framing surgical healthcare delivery can prove to be beneficial for the environment. Future surgeons should be trained and encouraged to opt for one-stage surgical procedures which in the past have been done in two stages. This is more eco-friendly, as it allows shorter hospital stay, reduced expenditures, lesser operating time, decreased drug usage, and lesser utilization of PPE.[2] Similarly, implementation of alternative techniques for anaesthesia, instead of anaesthetic gases, can decrease their ecological impact.[13] Use of broad-spectrum prophylactic antibiotics must be rethought,[2] with their clinical benefit weighed against the harm they pose to the environment in terms of increasing antimicrobial resistance.

Lastly, at times, unprecedented events like the COVID-19 pandemic open the door to several hitherto underutilized options. Surgical tele-consultation services help save travel and associated pollution from vehicles.[4,7] Moreover, it is high time that medical documentation be computerized for paperless records.[7]

Research: Research is the foundation for evidence-based eco-surgical strategies and interventions.[4] Particularly important is the evaluation of the safety, environmental impact, and cost-effectiveness of measures pertaining to recycling, reusage, and waste reduction.[2,13,14] Formation of interdisciplinary groups for regular audits and evaluation of eco-surgical interventions, along with a focus on educational and awareness programmes, are essential in achieving eco-friendly surgical healthcare.

Development of Environmentally Protective Surgical Techniques: In evaluating the environmental impact of surgery, studies have compared the cost effectiveness and carbon footprint of surgical procedures across many sub-specialties. Cataract surgery is the most frequently conducted surgical procedure globally and has a variety of techniques: phacoemulsification, manual small-incision cataract surgery (MSICS), and femtosecond laser-assisted cataract surgery (FLACS).[15] There is great variability in global waste production in cataract surgery, with phacoemulsification producing between 0.19-4.27 kg of solid waste and 41-130 kg carbon dioxide equivalents (COe) per case, while MSICS produces between 0.18-2.29 kg of solid waste and 40-119 kg COe per case.[16] MSICS has also proven more cost-effective than phacoemulsification,[15,17,17] while FLACS is the least cost-effective,[15] suggesting that the use of MSICS could prove effective in low-resource setups.

It is important that newly introduced surgical innovations confer ecological advantages, in addition to clinical and cost benefits. The SOFT COAG is a novel and unique mode of the electrosurgical unit, which may be used to control intraoperative bleeding.[19] By generating "joule heat" and automatically regulating output voltage, SOFT COAG denatures proteins without producing carbonization of tissue. This allows intraoperative haemostasis while significantly reducing the use of suturing for intra-operative, lowering both costs and waste production. In addition to improving the efficiency of treating intra-operative bleeds, the SOFT COAG can be autoclaved and reused around 100 times providing a great ecological advantage over single-use sutures in everyday operations.[19] Additionally, a study utilized a new BiClamp reusable sealing instrument along with the SOFT COAG as an alternative to automatic staples in pulmonary resection operations.[20,21] Within the trial, it was assessed that the BiClamp is an effective alternative to the conventional mechanical stapler in separation of unseparated interlobular fissures in pulmonary lobectomy.[20] In addition to having comparative operative time, intraoperative bleeding, and postoperative complications, use of the BiClamp reduced the operative cost, environmental impact, and carbon emissions associated with mechanical staples.[20,21]

Minimally invasive surgery has displayed lower overall CO2 emissions than open surgery,[22] should be the approach of choice wherever possible. However, artificial intelligence-based robotic surgery, which is making great strides, has substantially inferior cost-efficiency and greater waste production.[23] In light of the ever-evolving field of surgery, there is need for adequate prioritization of the environmental benefit of newer surgical techniques, equipment, and procedures.[23]

Role of Hospitals in Eco-Surgery: Despite being havens of healing, hospitals worldwide are responsible for considerable amounts of hazardous emissions and toxic waste products. In today's climate, it is crucial that hospitals re-evaluate their responsibilities in relation to environmental sustainability, in order to preserve nature for current and future generations.[24,25] In recent years, the advent of various initiatives and organizations such as Healthcare without Harm and Coalition for Green Health Care have been vital in introducing and promoting the concept of the "Green hospital".[26] Several hospitals around the world have already begun implementing measures to reduce their environmental footprint.[27] Recommendations for hospitals in Pakistan are summarized in Table-2.

Policies and Measures: One of the first steps to a more ecofriendly health care system is the development of robust policies. Energy efficiency is one such area of improvement. The health sector consumes significant

Table-2: Specific Recommendations for Eco-Friendly Surgery in Pakistan.

Type of Intervention	Specific measures that can be taken
Policies and Measures	◆ Energy Efficiency • employ conservation policies to reduce energy consumption by a certain percentage in every year[28] • assess baseline emissions and develop appropriate action plans[24] ◆ Waste Management • develop a detailed waste management system[29] • Employ the use of sustainable non-burn treatment technology[28] • Purchase recycled, reusable products • Adopt formal environmental management systems adhering to EMAS or ISO standards[30]
Structural Modifications	◆ Alternative Energy • Invest and install renewable energy sources, such as solar panels, wind turbines and CHP technology[27] ◆ Built Environment • Prioritize incorporating sustainable elements in the hospital design e.g Day lighting, green roof systems, natural ventilation[27,28] • Install energy-efficient lighting, thermal insulation and water conserving equipment • Retrofit outdated equipment[31,32]
Education	◆ Create awareness of the importance of environmental protection measures among employees ◆ Engaging the workforce through newsletters and holding environmental action days[24,31] ◆ Organize go green campaigns and encourage efficient use of resources ◆ Encourage workers to walk or use bicycles and public transportation whenever possible[27,31] ◆ Adopt waste reduction and recycling practices[28]
Performance Measurement	◆ Define goals pertaining to environment protection and employ relevant strategies ◆ Outline indicators to measure the success of the strategies employed[32]
Collaboration	◆ Create awareness among policy makers and legislative bodies about the detrimental effects of climate change ◆ Health ministries must enforce climate friendly policies and develop action plans at national and international levels ◆ Agencies financing health care construction should ensure funds are utilized for development of ecofriendly health facilities ◆ Incorporate environmental health policies into hospital accreditation standards[27,28]

amounts of fossil fuels and contributes to considerable greenhouse gas (GHG) emissions. Hospitals must aim to establish an energy usage baseline, as well employ energy conservation policies to reduce energy consumption by a certain percentage in every year.[28] In addition, hospitals must periodically assess their contribution to pollution and greenhouse gas emissions and develop action plans for reducing it.[24] Moreover, it is important that hospitals develop a detailed waste management system, laying out the protocol to be followed on the special handling, segregation, storage and transportation for hazardous wastes.[29] Non-burn treatment technology can be used to ensure that the waste is disposed of in an economical, safe and environmentally sustainable manner.[28] In addition, implementation of standard purchasing practices such as buying reusable instead of disposable products, or recycled ones, and prohibiting the purchase of materials containing toxic elements such as mercury and PVC.[27] Lastly, adopting formal environmental management systems adhering to EMAS (Eco-Management and Audit Scheme) or ISO standards is a good practice for hospitals to monitor quality assurance and carry out informed actions.[30]

Structural Modifications: Hospitals should consider investing in sources of clean and renewable energy, such as solar panels and combined heat and power (CHP) technology, whereby waste heat produced from on-site electricity generation can be captured and utilized as thermal energy for heating purposes.[27] In addition, hospitals can plan energy efficiency into the hospitals infrastructure by installing meters to measure electricity consumption, using thermal insulation and conserving water by installing efficient faucets and toilets. Wherever possible, hospitals must prioritize sustainable and eco-friendly designs and plans for hospital infrastructure. Day lighting, green roof systems, natural ventilation and gardens and supporting the use of local, using recyclable materials for construction are a few examples.[27,28] Furthermore, hospitals should employ the use of ecofriendly technology by setting up cogeneration units, installing inverter air conditioners, and retrofitting outdated equipment.[31,32]

Performance Measurement: For hospitals, measuring environmental performance is an invaluable tool to assess and reflect on the effectiveness of current policies for environmental sustainability. Following the framework proposed by Blass et al,[33] the first step is to define goals pertaining to environment protection, after which robust strategies are deployed. The effectiveness of these

strategies are measured by selecting performance indicators that are measurable, valid and controllable.[33,34] These could include electrical power consumption, water withdrawal from source, direct and indirect greenhouse emissions, and unit weight of waste material.[32] Performance data should then be compiled and used to inform future decisions and formulate improved strategies.

Education: Healthcare systems can only achieve environmental sustainability with the cooperation and dedication of the workforce involved. Hospitals should aim to make hospital staff and the general public aware of the importance of environmental protection measures and the health sector's role in mitigating climate change. Engaging the workforce through announcements via newsletters, holding environmental action days, and organizing "go green" campaigns" could help embed the concept of environmental sustainability into the hospitals culture.[24,31] Moreover, hospitals should also encourage workers to walk or use bicycles and public transportation whenever possible to limit emissions, or to take the stairs instead of elevators to reduce electricity usage.[27,31] Hospitals could also introduce periodic training programme to teach healthcare workers proper waste management and disposal, and constructively correct bad practices and educate employees about their behaviour.[32] Lastly, hospitals should develop institution-specific waste reduction policies and regularly educate employees about the importance of their role in achieving institutional targets.

Collaboration: Around the world, environmental sustainability policies are either insufficient, poorly funded or entirely absent. It is crucial now more than ever that health systems, government agencies and policymakers take action to reduce the impact of the healthcare sector on the environment. Health ministries must create awareness among policy makers, and governing and legislative bodies, about the detrimental effects of climate change and healthcare sector's role in mitigation. They must also enforce climate friendly policies and develop action plans at national and international levels. Multilateral and bilateral aid agencies that finance health care construction should ensure that funds are utilized to promote the development of ecofriendly health facilities. Institutions that accredit hospitals are encouraged to incorporate environmental health policies into their accreditation standards, thus promoting green hospitals and fostering environmental sustainability. The healthcare sector should collaborate with stakeholders and strengthen cross-disciplinary partnerships to ensure that mitigation measures are not just limited to healthcare facilities, but extend to other sectors as well.[27,28]

Conclusion

The daily surgical procedures in hospitals have a drastic impact on the environment that goes unnoticed and unaddressed. Small measures at surgical and hospital level can pave the roadway to eco-friendly surgery practices. Establishment of waste management systems, creating awareness, modifying the current structure, utilization of eco-friendly surgical techniques, and implementation of 5R's (reduce, reuse, recycle, rethink and research) can prove to be vital. Although it might be challenging for Pakistan, but gradual changes can help make a better future.

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Perioperative registries in resource-limited settings: The way forward for Pakistan

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Abstract

Capable of improving surgical quality, perioperative registries can allow performance benchmarking, reliable reporting and the development of risk-prediction models. Well established in high-income countries, perioperative registries remain limited in lower- and middle-income countries due to several challenges. First, ensuring comprehensive data entry forums to power the registries is difficult because of limited electronic medical records requiring sustained efforts to develop and integrate these into practice. Second, lack of adequate expertise and resources to develop and maintain registry software necessitates the involvement of software developers and information technology personnel. Third, case ascertainment and item completion are challenging secondary to poor-quality medical records and high loss-to-follow-up rates, requiring telemedicine initiatives as an adjunct to existing care for the assessment of post-discharge outcomes. Lastly, standardised coding of clinical terminology is warranted for ensuring interoperability of the registries for which adaptation of the existing disease and procedural codes can be a sustainable and cost-effective alternative to the development of new codes.

Keywords: Perioperative care, Registries, Evidence-based practice, Quality improvement, Pakistan.

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Introduction

In the field of surgery, regularly assessing trends in incidence of major postoperative complications is essential globally. For this purpose, the development of perioperative registries (PORs) has proved to be a reliable and cost-effective approach.[1] PORs are high-quality datasets powered by sustained collaborations among multiple surgical facilities. These registries incorporate the findability, accessibility, interoperability and reusability (FAIR) principles of data management, allowing benchmarking of hospital performance, reliable reporting of postoperative outcomes, and development of risk-prediction models, collectively leading to improved quality of surgical care.[2-4]

In lower- and middle-income countries (LMICs), surgical facilities are burdened with inadequate quality of surgical care, owing to the challenges in building and maintaining surgical capacity in resource-constrained settings.[5] Compared to high-income countries (HICs), such resource-limited environments require more sophisticated and targeted surgical capacity-building initiatives, considering the greater potential for improvements in the quality of surgical care. While PORs have been well established in HICs, their implementation remains limited in LMICs, including Pakistan.[6]

The current review was planned to highlight the multifarious benefits of implementing perioperative registries in resource-constrained environments, such as Pakistan, to discuss the potential challenges that can hinder this process, and to suggest potential solutions which can be incorporated in LMICs.

Why the registries?

PORs are essential to facilitate improvement in the existing quality of surgical care, to allow continuous surveillance, and to promote surgical research (Figure).

The quality of surgical care plays a decisive role in the morbidity, mortality and quality of life (QOL) of patients undergoing surgery. However, there is very limited evidence available evaluating the quality of perioperative care (POC) in low-resource settings.[7] Research has shown that approximately 60% of avoidable deaths worldwide are secondary to low quality of care.[6] Therefore, particularly for LMICs such as Pakistan, efforts in improving access to healthcare cannot sufficiently translate into better health outcomes without improvement in the quality of care.[6,7]

Utilisation of PORs to improve patient safety and quality of care warrants a stepwise approach. First, the quality of

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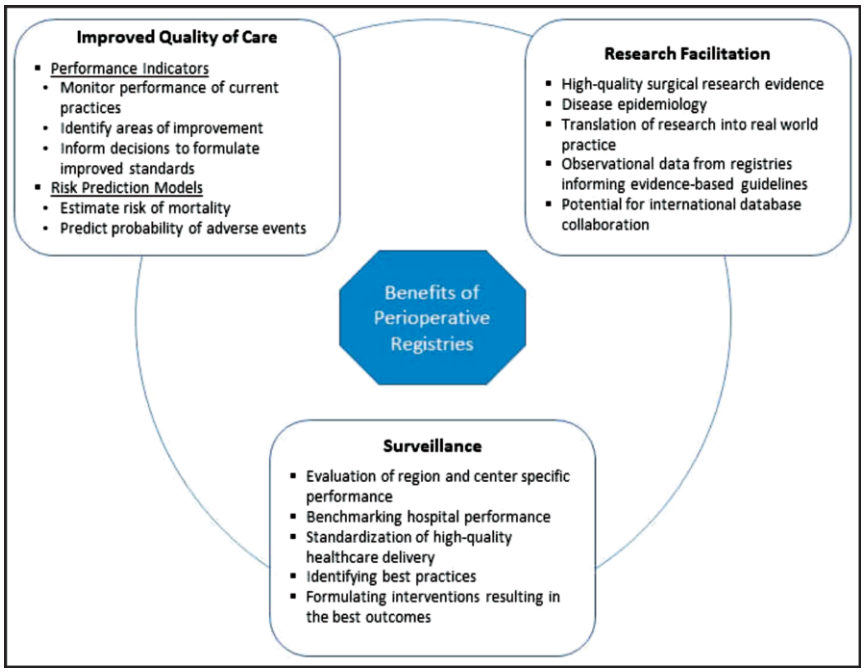

Figure: Potential benefits of implementing perioperative registries in Pakistan.

surgical care needs to be quantified using quality indicators. Ensuring that the selected quality indicators are both specific to assessing POC quality in an LMIC setting is imperative. Haller et al. identified several promising quality indicators that can be implemented as endpoints in the assessment of quality of surgical care even in resource-constrained settings. These included admission to the intensive care unit (ICU) within 14 days of surgery, length of hospital stay (LOS), surgical site infection (SSI), stroke, hospital readmission, and mortality within 30 days of index surgery.[8]

Second, the selected quality indicators need to be incorporated into hospital, regional, and national PORs in LMICs, including Pakistan. The data generated by these registries can subsequently allow the assessment of existing surgical practices and protocols, identify areas of improvement, and inform evidence-based decisions to ensure better quality of surgical care.[3,6,9,10] The National Surgical Quality Improvement Programme by the American College of Surgeons (ACS-NSQIP) is one of the most widely used PORs globally. Compared to the incidence rates in earlier years, participation in ACS-NSQIP has shown annual risk reduction of 0.8% for mortality, 3.1% for one or more morbidity events, and 2.2% for SSIs.[11]

Additionally, evidence from these registries can also facilitate the development of risk prediction models for adverse surgical outcomes. Such models consider the relevant risk factors and predict the probability of adverse events post-surgery for individual patients, informing surgical decision-making. An example of such a model is the risk calculator by the Society of Thoracic Surgeons (STS), powered by its national perioperative database.[12,13]

Furthermore, PORs also allow healthcare workers, medical governing bodies, and policymakers an avenue for continuous surveillance. Data from these registries can allow evaluation of regional and centre-specific performance along with enabling comparison of different surgical practices in hospitals. Such registries can facilitate benchmarking of hospital performance, thus allowing for standardisation of high-quality and efficient surgical POC in hospitals across Pakistan.[3,4]

Another advantage of PORs is research facilitation, particularly in a resource-constrained setting, like Pakistan. A majority of existing surgical research evidence in Pakistan is based on single-centre experiences with inadequate quality to inform surgical practice.[14] Consequently, evidence-based guidelines exist currently, but are usually powered by data extrapolated from HICs and upper-middle-income countries (UMICs).[15] Regional and national PORs can generate high-quality evidence specifically for the Pakistani setting, facilitating evidence-based surgery in the country.

In addition, data from established registries can be used to explore the trends in patient demographics and risk factors for adverse surgical outcomes over time.[16] This can facilitate research in disease epidemiology to gain better understanding and discern patterns of changing surgical indications in the population. PORs also provide an avenue to monitor the impact of different quality improvement interventions and guidelines using actual patient outcomes, demonstrating the translation of research into real-life practice.[4] Data from registry-based observational studies can also inform evidence-based guidelines in instances where clinical trials are not available.[16] With large datasets and subsequent integration, there is potential for national and international collaboration in research, combining the strengths of each individual database.[3]

Registries in Pakistan

In recent years, some surgeon-led collaborative approaches have successfully resulted in the

Table: Institutional, national and international perioperative registries functional in Pakistan.

Registries	Developed by	Patient Population	Data Sources	Quality Indicators
Institutional registries				
Karachi Trauma Registry (KITR)	Aga Khan University Hospital, Karachi National registries	All cases admitted to the emergency department of AKUH with a trauma history of less than 24 hours. Patients shifted to AKUH from other hospitals and having ICD injury codes of ICD-9-CM 800-959.9. Cases of isolated hip fractures, poisoning, and expiry on arrival are excluded.	Data is retrieved from patient medical records, such as doctors' and nurses' notes, laboratory and radiology reports, and discharge summaries. In addition, daily accounts of all ED visits are obtained from electronic data systems. These include information regarding patient demographics, primary reason for visit, and disposition. Data on patients with injuries is also captured from triage, admission, and ED discharge lists.	Delay in reaching hospital, length of stay in the emergency department, total length of stay in the hospital, discharge from emergency, predicted and actual survival.
National registries				
Pakistan Registry of Intensive CarE (PRICE)	PSCCM, ICS, and NICST	All planned and unplanned admissions in the five member ICUs from Karachi, Lahore, and Islamabad, having a total of 104 ventilated beds.	Similar to the NICST registry, the admission characteristics and diagnosis are recorded daily for each patient. Collaborating facilities report data at their own accord via a protected, cloud-based mobile/desktop portal that has been established by researchers and clinicians in Srilanka. Nominated local coordinators conduct weekly telephonic calls to obtain admission numbers from non-digitalized data within each ICU.	Mortality, quality of life
Pakistan National Joint Registry (PNJR)	Pakistan Arthroplasty Society (PAS) International registries	All patients undergoing arthroplasty surgery in implant companies and hospitals.	Case report forms, inform up forms, follow up form.	Adverse intraoperative events, postoperative weight bearing, implant details, and postoperative rehabilitative protocols.
International registries				
ACS-NSQIP	ACS	Patients undergoing surgery in all 700 hospitals that are in collaboration with NSQIP.	Data from preoperative management till 30 days postoperatively of randomly selected patients are collected prospectively by trained reviewers assigned by each hospital. Data are then entered on a web-based platform accessible 24 hours a day. Variables can vary between hospitals based on patient population, hospital characteristics, and focus of quality improvement. Blinded, risk-adjusted information is shared with all hospitals, allowing them to benchmark their complication rates and surgical outcomes.	30-day mortality, unplanned intubation, prolonged ventilator dependence (>48 hours), surgical site infections (superficial, deep, or organ/space), urinary tract infections, sepsis, septic shock, wound disruption, pneumonia, clostridium difficile colitis, delayed discharge (>30 days from principal procedure), unplanned reoperation(s), unplanned readmission(s), and hospital discharge destination.

ED: Emergency department, AKUH: Aga Khan University Hospital, ICU: Intensive care unit, PSCCM: Pakistan Society of Critical Care Medicine, ICS: Intensive Care Society, NICST: Network for Improving Critical Care Systems and Training, ACS-NSQIP: American College of Surgeons-National Surgical Quality Improvement Programme, ACS: American College of Surgeons.

implementation of a few institutional, national, and international PORs in Pakistan (Table). Among the institutional registries, a classic example is that of the Karachi Trauma Registry (KITR) established by the Aga Khan University Hospital (AKUH) in October 2009. KITR is a locally developed, electronic registry that utilises data from existing medical records at the hospital. KITR has been able to generate surveillance data, such as injury mechanisms and burden of severe injuries, quality indicators, such as length of stay in the emergency department (ED), injury-to-arrival delay, and injury severity, and survival probability.[17]

With regards to the national registries, the Pakistan Registry of Intensive Care (PRICE) and the Pakistan National Joint Registry (PNJR) are currently functional. PRICE is a contemporaneous registry developed by the Pakistan Society of Critical Care Medicine (PSCCM), Intensive Care Society (ICS) of the United Kingdom, and the Network for Improving Critical Care Systems and

Training (NICST). Being a clinician-led real-time registry, PRICE involves extensive collaboration between surgeons and administrative personnel involved in intensive care delivery, allowing the recruitment of ICUs from both public and private hospitals. Admission characteristics along with the diagnosis are documented for each admitted patient requiring intensive care. Data without any patient identifiers is displayed in control panels, facilitating the researchers to assess the trends in unit activity, severity of illness, bed occupancy and outcomes.[18]

PNJR is a voluntary project which has been conceived, designed, implemented and funded by the Pakistan Arthroplasty Society (PAS). Implant companies and hospitals can retrieve data from PNJR for conducting surgical research aimed at improving quality of care and safety for patients undergoing arthroplasties.[19]

Apart from the regional and national registries, Pakistan, being a resource-limited country, has not contributed significantly to the conception, design or implementation of any international POR. However, the AKUH has recently partnered with the ACS-NSQIP, contributing its patient data to this registry. ACS-NSQIP is a multi-institutional programme with currently 700 partnering hospitals worldwide. Trained surgical reviewers at each hospital collect data on numerous variables, including demographics, comorbidities, preoperative laboratory parameters, operative characteristics, and outcomes. ACS-NSQIP provides semi-annual reports to each hospital on the basis of the submitted data. This report benchmarks the performance of each hospital in comparison with the performance of an estimated average partnering ACS-NSQIP hospital performing the same procedures on the same patients. This allows hospitals to evaluate their performance compared to other partnering hospitals, driving continuous quality improvement initiatives.[20,21]

Despite these commendable efforts by the surgical community, the implementation of PORs remains limited in Pakistan. A majority of surgical facilities have not developed institutional registries and are not actively participating in national registries. Similarly, the ACS-NSQIP has not been implemented in most Pakistani hospitals. Considering the multifarious benefits of PORs, assessing the challenges involved in the implementation of these registries is imperative and can help identify the way forward for Pakistani surgical facilities.

Challenges and limitations in low-resource settings

Despite the commendable efforts by the surgical community, the number of PORs remains limited in Pakistan as is the case in other LMICs.[22] As highlighted earlier, there is a dire need for surgical registry data from low-resource settings to improve patient safety and to regulate surgical practices. However, a low-resource environment poses several challenges to the establishment of such PORs.

First, the process of development and plot implementation for a POR begins with the establishment of a uniform and comprehensive data entry forum. However, electronic medical records (EMRs) are currently lacking in resource-limited settings.[23] Implementation of EMRs warrants a higher cost of setup and maintenance in such settings, owing to poor existing infrastructure, frequent power outages, and network failures. Even in facilities that have implemented EMRs, utilisation mostly remains suboptimal secondary to the requirement of parallel data entry to paper and computer records, increasing the workload of already limited staff.[23-26] As a result, administrative data from EMRs is currently inadequate to power PORs in several settings, making the surgeons primarily responsible for capturing data related to patient care.[6] This situation warrants allocation of appropriate resources aimed at development and integration of sustainable administrative EMRs into the existing care to replace paper-based records. Such EMRs should also incorporate user-friendly software capable of continuous data synchronisation to safeguard data during potential power outages and network failures.

Second, PORs require efficient and secure software to power them. However, LMICs have limited expertise and resources for developing and maintaining appropriate registry software.[17] This can potentially be resolved with appropriate training, recruitment and integration of software developers and information technology (IT) personnel in the existing healthcare systems. This integration will also contribute to the generation of new jobs which can potentially improve employment rates across the LMICs.

Third, case ascertainment and item completion for PORs pose multifarious obstacles. Appropriate and carefully selected clinicodemographic characteristics, comorbidities, preoperative laboratory parameters, operative characteristics, and quality indicators need to be incorporated into the PORs.[17] However, data reporting and recording systems in most resource-constrained settings produce poor-quality data.[28] In a recent study in Tanzania, history of patients, daily progress notes, and daily surgeon orders were not included in 24%, 59% and 71% of the medical records, respectively.[29] In addition, the assessment of several surgical quality indicators

requires following patients post-discharge till the 30th day of index surgery.[8] The surgical population in LMICs experiences high loss-to-follow-up rates, ranging from 32% to 75%.[30,31] This situation necessitates the development of standardised EMRs to improve case completeness and implementation of telemedicine initiatives as an adjunct to existing surgical care for adequate assessment of quality indicators in the LMICs.[31,32] In addition, adequate and continuous training of administrative staff in data collection and development of comprehensive surgical checklists should be prioritised to improve data quality.

Lastly, when implementing PORs, it is essential to ensure the incorporation of the principle of interoperability.[2] This standardised system of health information exchange among collaborating surgical facilities warrants technical system design considerations described earlier in addition to uniform coding of clinical terminology.[33] For resource-limited settings, adaptation of existing disease and procedural codes, such as the International Classifications of Diseases (ICD) and Current Procedural Terminology (CPT) codes employed by the ACS-NSQIP, can be a more sustainable and cost-effective approach compared to the development of new codes.[20]

Conclusion

Establishing and implementing PORs is challenging in resource-limited environments, such as Pakistan. However, existing surgeon-led efforts have demonstrated that institutional and national bodies can collaborate and maintain PORs even in Pakistan. While these registries have been limited to a few partnering hospitals, they represent the first step towards a nationally representative Pakistani POR. Sustained contributions from the surgical community in Pakistan are needed to overcome the highlighted barriers and develop a data network capable of interpreting risk-adjusted surgical outcomes across the country. Such a network could not only promote evidence-based improvements in the quality of surgical care in Pakistan, but may also allow continuous surveillance, performance benchmarking and research facilitation.

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STUDENTS' CORNER
SHORT REPORT

Path to publication: A peer mentorship model for student-lead surgical research

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Abstract

Early and sustained involvement in research is imperative for medical students to ensure better career prospects in addition to provision of high-quality, evidence-based care to patients. However, involvement of students in surgical research still remains limited, owing to inadequate research training. The current paper was planned to describe the structure of the "Path to Publication" series, incorporating peer mentorship with capacity-building research workshops for medical students. A total of 25 students were grouped into 8 surgical subspecialty groups to conduct research, supervised by experienced student research and faculty mentors. In addition, a series of research workshops were organized in synchronization with the different phases of research for all groups, equipping medical students with the necessary skills needed for each phase. This initiative has successfully equipped medical students with research skills in addition to involving them in surgical research, helping to advance their research careers and promote evidence-based surgery in Pakistan.

Keywords: Evidence-based care, Research, Surgery, Medical students, Capacity building.

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Introduction

Research comprises a significant portion of medical education in addition to forming the crux of evidence-based medicine.[1,2] Early, active, and sustained involvement in research is imperative for medical students to ensure better career prospects in addition to provision of high-quality, evidence-based care to patients.[1,3] This warrants medical schools to provide adequate research training and exposure to medical students.

The curriculum at the Aga Khan University (AKU) has a mandatory research module to provide research exposure to medical students. However, involvement of students in surgical research still remains limited, owing to inadequate research training in idea conceptualization, study design, protocol writing, obtaining ethical approvals, data collection, statistical analyses, and manuscript writing.[4]

The concept of peer mentorship in medical schools encompasses a formal relationship in which a student with adequate expertise provides guidance and support to other students.[5] Evidence has shown that peer mentorship programmes significantly enhance research interest and productivity among medical students.[6,7] In addition, research capacity-building workshops can potentially improve the quality of surgical research conducted by medical students.[8]

This manuscript was planned to describe the structure of the "Path to Publication" series which incorporated peer mentorship with capacity-building research workshops and facilitated surgical research by medical students at AKU.

Methods and Results

Path to Publication series resulted from a collaboration between the research division of the Surgery Interest Group (SIG) and the Society for Promoting Innovation in Education (SPIE) at AKU. A sign-up application was disseminated to medical students at AKU, collecting data on prior research experience, research skills, and fields of interest. Based on these characteristics, students from basic sciences and clinical years were matched together and grouped into specific subspecialty research groups.

Each group was mentored by one student research mentor from either SIG or SPIE with extensive research experience and was tasked with conducting surgical research as per their specific subspecialty. The role of mentors included teaching necessary skills for research to their group, including idea conceptualization, referencing, protocol writing, data collection, data analyses, and manuscript writing.

In addition, a series of student-led workshops were organized to facilitate this process and provide adequate training to all groups. These included the Introduction to Path to Publication, Protocol Writing & Ethics Review

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Table: Workshops planned as part of the Path to Publication series.

Workshop/session	Setting	Objectives
Introduction to Path to Publication	Lead by a student research mentor over Zoom	- Details about Path to Publication - Types of research & hierarchy of evidence - How to come up with potential research ideas relevant to specific subspecialties
Protocol Writing & ERC Applications	Lead by a student research mentor over Zoom	- How to write a study protocol - An overview of ERC application process and requirements
Protocol Feedback Session	Lead by a panel of student research mentors over Zoom	- Each group presented their protocol and received feedback from all mentors

ERC: Ethics Review Committee.

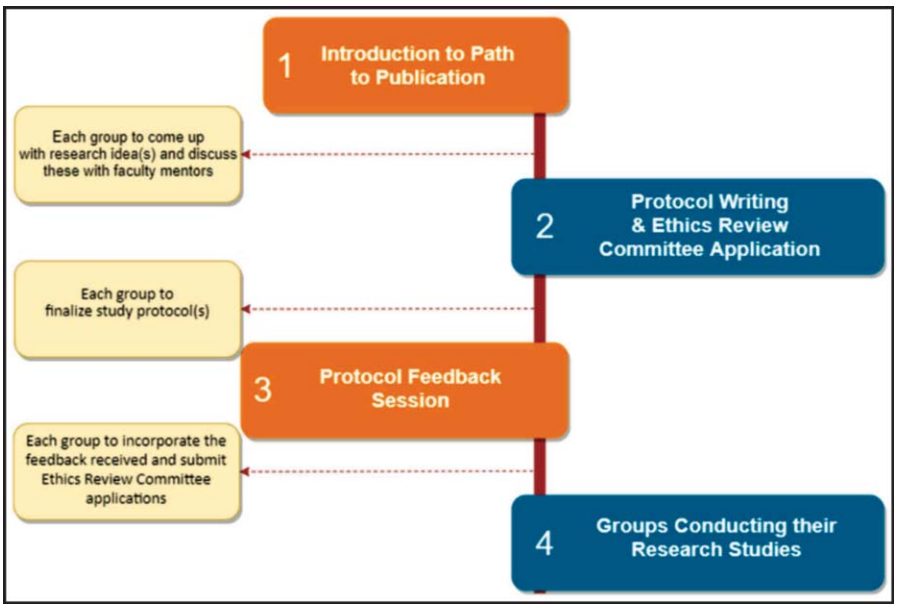

Figure: Sequence of events in the Path to Publication series.

Committee (ERC) Application, and the Protocol Feedback workshops (Table). The timing of these workshops was planned such that they coincided with relevant phases of research for all groups (Figure).

Out of 100 medical students who filled the application, 25(25%) students were selected and grouped into 8 subspecialty groups. These included breast surgery, cardiothoracic surgery, neurosurgery, obstetrics and gynaecology, ophthalmology, orthopaedic surgery, paediatric surgery, and plastic surgery. All subspecialty groups managed to develop their study protocols and are currently conducting their respective studies under the guidance of faculty mentors from the Department of Surgery at AKU. These studies will soon be published in peer-reviewed journals with some of them being presented at national or international surgical conferences as well.

Discussion and Conclusion

The Path to Publication model has proved itself to be a successful model that can be employed to train medical students in research skills and involve them into surgical research. This is essential for promoting the concept of evidence-based surgery in Pakistan. However, despite increasing interest among students, there is very little exposure to surgical research in medical education. Lack of awareness regarding existing research opportunities, weak rapport with competent professors, and inadequate research skills are common challenges faced by medical students from engaging in surgical research.[9] In addition, students who manage to get involved in surgical research are usually tasked with data collection and not the other phases of research, restricting active learning.[10]

SIG and SPIE at AKU has provided a novel model incorporating peer mentorship with carefully timed capacity-building research workshops to facilitate surgical research among medical students. An equal representation of medical students from basic sciences and clinical years was ensured in each subspecialty group. This diversity allowed various perspectives while designing a research question. A pre-organized and carefully planned timeline allowed all groups to conduct their projects in synchronization with the capacity-building workshops. Considering most medical students have inadequate research skills, this synchronization equipped them with the necessary skills needed for each research phase.[6] In addition, the involvement of capable research mentors helped further to meet the need for adequate training and guidance. Faculty mentors were also involved to ensure clinical relevance of the selected research questions by each subspecialty group.

In a period of three months, a significant number of medical students were equipped with adequate research skills. These skills were subsequently implemented as each subspecialty group conceptualized appropriate surgical research questions, designed study protocols, approached faculty mentors, and applied for ERC approvals. Without Path to Publication, it is unlikely that so many students would have had this opportunity of learning the necessary research skills while being involved in surgical research. Based on this, it can be inferred that the Path to Publication model has significantly bridged the gap between medical students and high-quality surgical research.

The Path to Publication model can be successfully implemented in other medical colleges in Pakistan to enhance robust surgical research output from medical students. SIG and SPIE aim to facilitate this process via their respective national ambassador networks with representation from most medical colleges in Pakistan. Through this, we hope to simultaneously advance the research careers of medical students while promoting evidence-based surgery to improve patient outcomes.

Acknowledgement: We would like to thank the Surgery Interest Group, the Society for Promoting Innovation in Education, and the Department of Surgery at the Aga Khan University for their contributions to the Path to Publication series.

Disclaimer: The abstract of this manuscript has not been presented or published in a conference or abstract book. This article is not part of a PhD thesis.

This study describes a peer mentorship model employed at the Aga Khan University to provide surgical research training and experience to undergraduate medical students. Accordingly, no statistical tests were used in this paper, and hence, formal sample size estimations were not conducted.

Conflict of Interest: None to declare.

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STUDENTS' CORNER
SHORT REPORT

Surgical training in ophthalmology: Role of EyeSi in the era of simulation-based learning

Sehrish Nizar Ali Momin, Abdul Sami Memon, Muhammad Bilal Malik, Pir Salim Mahar

Abstract

Recent advancements in surgical training methods have escalated the need for simulators. The EyeSi simulation has played a major role in Ophthalmology training by providing opportunity to the novice residents to grasp the surgical steps of the procedure and master the skill by repeated attempts. Participants were assessed on single level of cataract module and their consecutive scores were assessed with each attempt. It was found that repetitive practice on simulator can help develop proficiency in the desired steps that can ultimately prepare the surgical trainees for real life surgery.

Keywords: Virtual reality, Simulator, Surgery, training, Ophthalmology, Oph-thalmologic surgical procedure, Surgical Specialties.

DOI: https://doi.org/10.47391/JPMA.AKU-26

Introduction

The expanding era of virtual reality has led to the evolution of simulators that have been a desirable machine in achieving perfection at a given task in various fields. Ophthalmology has an edge of short and quick procedures that require manipulation in limited space mandating the need for prior practice before performing on to a patient in real life. The EyeSi Surgical Simulator (VRmagic, Mann-heim, Germany) is the predominant simulator used for training in both cataract and vitreoretinal surgery in ophthalmology.[1]

The module comprises of levels with increasing difficulty that cover all steps of a basic cataract surgery and vitreoretinal surgery. Several studies have extensively studied the predictive and construct validity of the Cataract surgery module.[1-4] Various other factors have been studied that include complication rate in cataract surgery following simulation learning.[5]

With the EyeSi simulation facility available at our setting, the aim of this study is to identify consistent or improving scores following a repetition of the same level in a cataract surgery module on EyeSi simulator. This was performed by various participants, with different levels of experience on EyeSi and real-life surgery, which could help assess the learning curve.

Methods and Results

The study included 8 participants that involved consultants, residents, and re-search fellows with varying level of real-life surgical hands-on experience. The identity was kept anonymous while the scores were gathered. Evaluation was based on a single step of capsulorhexis performed on EyeSi system available at the Aga Khan University Hospital Karachi, Pakistan. The data was obtained between 2nd-31st August 2021.

A single level of Cataract module labelled as "Capsulorhexis-High tension without guiding elements" was selected and a complete central curvilinear capsulorhexis was performed using any instruments of the participant's choice. Each participant was given 6 attempts, 3 consecutive attempts on day 1 and then 3 consecutive attempts after one week. Probability of achieving high scores or consistently improving scores were assessed. Machine has default criteria that scores the roundness, centering, deviation of rhexis radius from 2.5mm, maximum radial extension of capsulorhexis and local irregularities (spikes). It also scores on efficiency, instrument handling and tissue treatment.

The passing criteria set by the EyeSi programme is at 70% and requires 3 consecutive attempts. However, each attempt was independently recorded to document progression or decline in our participants with repetition of same level. Our hypothesis relied on a probable increasing score with each attempt thereby excluding any high scores that may have occurred by chance secondary to partially met criteria which doesn't fulfill the ultimate target.

The mean score of all participants in first attempt was 51.25 ± 34.6 as compared to the final attempt which was 78.75 ± 9.98 (Table). There was an increase of 27.5 points

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Table: Mean results of 8 participants undertaking 6 attempts of high tension capsulorhexis.

	1st Attempt score	2nd Attempt score	3rd Attempt score		4th Attempt score	5th Attempt score	6th Attempt score
High Tension without guiding elements							
A	67	94	86	One week interval	74	66	66
B	0	90	94		0	23	89
C	0	14	0		84	38	62
D	75	90	0		73	67	79
E	75	39	62		96	94	81
F	36	48	94		86	86	79
G	83	82	88		86	88	85
H	74	0	0		75	93	89
Mean	51.25±34.6	57.125±37.2	53±45.0		71.75±30	69.37±26.6	78.75±9.98

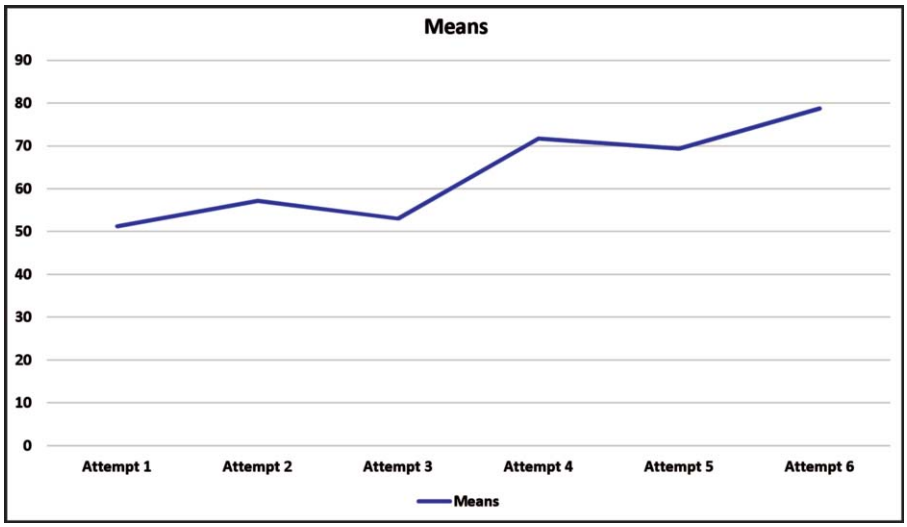

Figure: Graph showing rise in the mean scores with successive attempts.

obtained after repeated attempts which showed an overall improvement (Figure-1). Mean time for rhexis completion noted for all participant attempts combined was 2.34±1.41 minutes varying from maximum 8 minutes to minimum 1 minute. Instrument handling was scored excellent in majority attempts, and injured corneal area was 0 - 2 mm in most cases with only case injuring 5.3 mm of cornea.

The cumulative mean score in first 3 attempts was 53.8, and 73.3 in last 3 attempts. The improvement observed in the 3 attempts done on the subsequent week was drastic in comparison to initial 3 attempts with a difference of 19.5. It was observed that multiple attempts, with a gap in between, lead to better improvement in skill that may help in real life surgery.

Scoring for target achievement is based on roundness, centering, deviation, maximum extension, and irregularities of the capsulorhexis. There were differing scores of target achievement amongst the attempts, including attempts with same score but different individual parameters of the capsulorhexis. In one scenario, attempt score was 90-100, however the maximum radial extension was 2.3 mm which translates into a rhexis of 4.6 mm diameter, which in real life surgery is far from ideal and would not have achieved passing criteria if it was manually scored.

Discussion

The use of simulation nowadays is an integral part of residency training in majority of the hospitals in the developed world. EyeSi simulator has demonstrated construct validity in multiple studies and has shown to decrease complications rates amongst residents in comparison to controls.[6] We report a drastic difference in mean scores of the residents after one week interval with similar learning curve of skill improvement amongst all participants. Studies conducted previously had compared the outcomes of simulation-based learning with the real-life cataract surgeries. Thomsen et al assessed proficiency-based test on the EyeSi simulator with significant correlation to real-life performance, measured by motion-tracking software, of cataract surgical videos amongst 11 cataract surgeons.[7] Another study showed association of prior simulation training with statistically significantly lower difficulty scores on certain tasks performed during cataract surgery.[8] As the cost of acquiring EyeSi simulator falls between 150,000 - 200,000 US Dollars, it might be a difficult proposition to acquire it in a low-income country. Considering its availability, the use of simulator before hands on human eyes not only improves clinical skills but also corroborates patient's safety.

Conclusions

EyeSi simulator was found to have the ability to assess the scoring rate of participants engaging in different steps of cataract surgery. The most important benefit of using such simulation is that one can practice multiple times on this machine without putting any patient at risk.

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STUDENTS' CORNER
SHORT REPORT

PakSurg: The first trainee-lead model for multicenter surgical research collaboration in Pakistan

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Abstract

We describe creation and piloting of the PakSurg Collaborative, devised via integration of existing trainee-led collaborative models in the United Kingdom with the resource-limited surgical care in Pakistan. This is the first trainee-lead surgical research collaborative in Pakistan, established by the student-lead Surgery Interest Group from the Aga Khan University. The project involved creation of a model that included a steering committee comprising of five teams which worked in conjunction with collaborators from multiple hospitals. To facilitate this collaboration, a comprehensive and cost-efficient study management pathway was developed. The PakSurg Collaborative has the potential to deliver methodologically robust, high-quality, multicenter surgical evidence from Pakistan. This nationally representative data could inform evidence-based surgical guidelines, potentially translating into improved outcomes for patients undergoing surgery.

Keywords: Research, Surgery, Multicenter studies, Collaborative research.

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Introduction

In Pakistan, a majority of existing surgical research evidence is based on single-center experiences. The resulting evidence is generally limited by small sample sizes, lack of generalizability, and potential for bias.[1] Pakistan is a lower-middle-income country (LMIC) with limited resources available for research training and career development. There are limited funding opportunities available for surgical researchers. Consequently, the depth and quality of research output is inadequate to inform surgical practice.[2] Evidence-based surgical guidelines exist but are usually powered by data extrapolated from high- and upper-middle-income countries.[3] It is well-documented that LMICs face unique and diverse challenges in building and maintaining surgical capacity. Therefore, the validity of existing guidelines based on resource-rich environments is questionable.[4]

The trainee-lead collaborative research model has been developed within the surgical community in the United Kingdom.[5] This comprises of groups of trainees recruiting patients, collecting data, and submitting it over short patient recruitment windows. As a result, individual burden on trainees is significantly reduced while ensuring methodologically robust surgical research output, capable of informing surgical practice and improving the quality of care.[1,5-7] This collaborative model also allows delivery of high-quality evidence in a timely fashion, evidenced from the role that the COVIDSurg Collaborative has played in informing surgical practice during the coronavirus disease 2019 (COVID-19) pandemic.[8-11]

Despite allowing delivery of high-quality evidence from multicenter studies efficiently at minimal cost, the trainee-lead collaborative model has not been implemented in Pakistan till now. National research output from such a model could inform evidence-based surgery in Pakistan, improving perioperative outcomes and quality of surgical care for patients. We describe the formation of the first trainee-lead surgical research collaborative in Pakistan.

Methods and Results

The student-lead Surgery Interest Group (SIG) at the Aga Khan University (AKU), Karachi, Pakistan researched and reviewed models of existing national and international trainee-lead surgical research collaboratives. These included the GlobalSurg,[12] Global NeuroSurg Research Collaborative,[13] PancreasGroup,[14] STARSurg Collaborative,[15] BURST Research Collaborative,[16] and the Vascular and Endovascular Research Network.[17]

The logistical requirements and feasibility of integrating these models within a resource-constrained environment were discussed in multiple SIG internal meetings, and with the Department of Surgery and Centre for Global Surgical Care (CGSC) at AKU. An initial trainee-lead model

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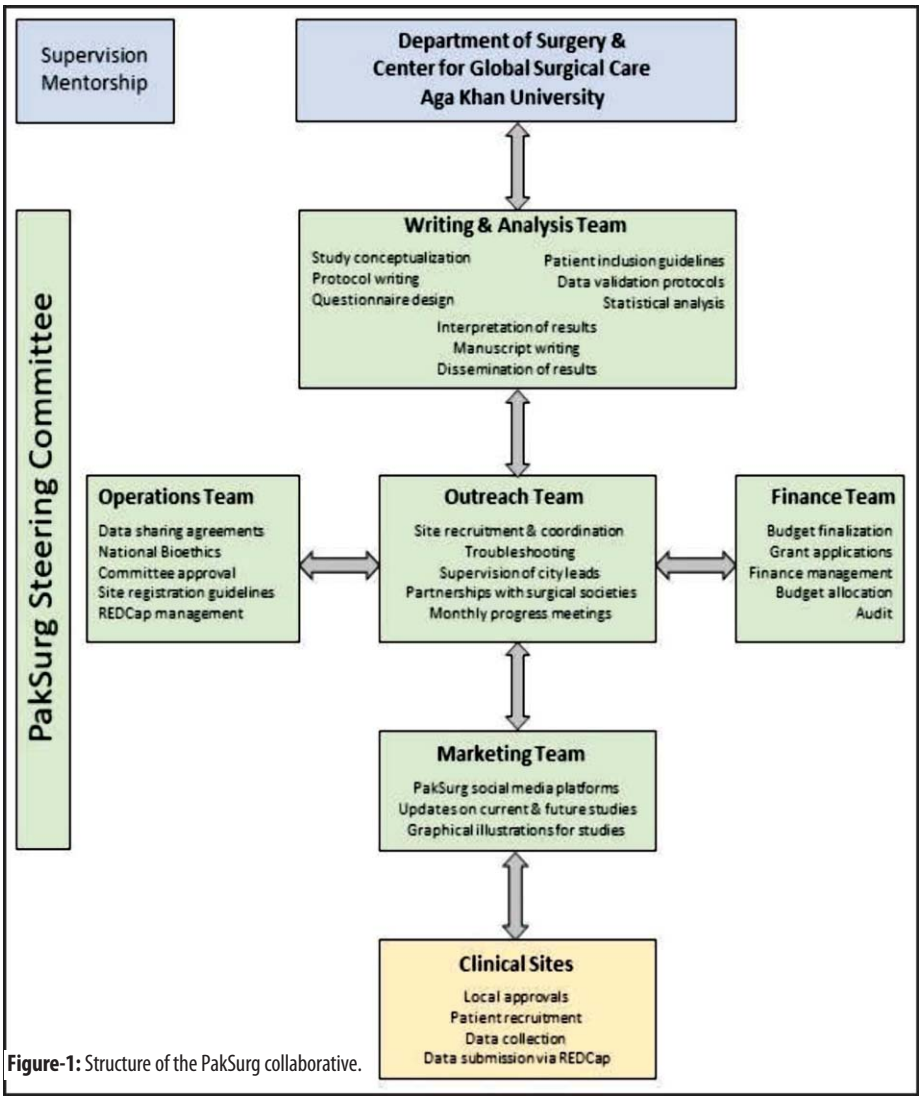

Figure-1: Structure of the PakSurg collaborative.

was developed after integrating the various international and regional models with the existing surgical practices in the Pakistani healthcare system.

To understand the limitations of implementing this model nationally from the point of view of institutional collaborators, SIG partnered with the GlobalSurg, the Global NeuroSurg Collaborative, and the PancreasGroup. During this phase, SIG selected students and trainees from AKU to recruit patients, collect, and submit data for surgical research studies by these collaborative groups. Virtual Zoom-based meetings were conducted with these students and trainees, and feedback was incorporated into the planned model.

To explore potential bottlenecks in implementing surgical studies in Pakistan, SIG collaborated with the Royal College of Surgeons in Ireland and led their RETAINER study in Pakistan.[18] For this purpose, SIG invited centers in Pakistan to collaborate via its National Ambassador Network. This network includes over 150 medical students and surgical trainees from 70 medical colleges and hospitals. A virtual meeting was held over Zoom, and study-specific details in addition to center registration pathways were presented and explained to the ambassadors. SIG was subsequently involved in processing registrations, assisting with local institutional approvals, and troubleshooting during patient recruitment, data collection, and data submission phases. Regular internal progress meetings and discussions with the Department of Surgery and CGSC were conducted to assess progress, consider limitations, and re-evaluate the planned model.

This exercise led to the creation of the first trainee-led surgical research collaborative in Pakistan, the PakSurg Collaborative. Under this model, the steering committee comprises of five teams working in conjunction to implement multicenter surgical research in Pakistan. This includes writing and analysis, outreach, operations, marketing, and finance teams (Figure-1).

Potential project proposals are adapted after an extensive peer-review process, with input from experts in the field. Only feasible research studies with relevance to the local context are selected. This is followed by piloting the selected study, adjusting methods and processes based on feedback, and implementing nationally after approval from the National Bioethics Committee (Figure-2). Local institutional approvals, patient recruitment, and data collection are managed by mini teams at each center, facilitated by the PakSurg Steering Committee. De-identified patient data according to a standardized proforma are submitted to the PakSurg Steering Committee via a secure network based on REDCap.[19] The PakSurg Steering Committee is subsequently responsible for data cleaning, validation, statistical analyses,

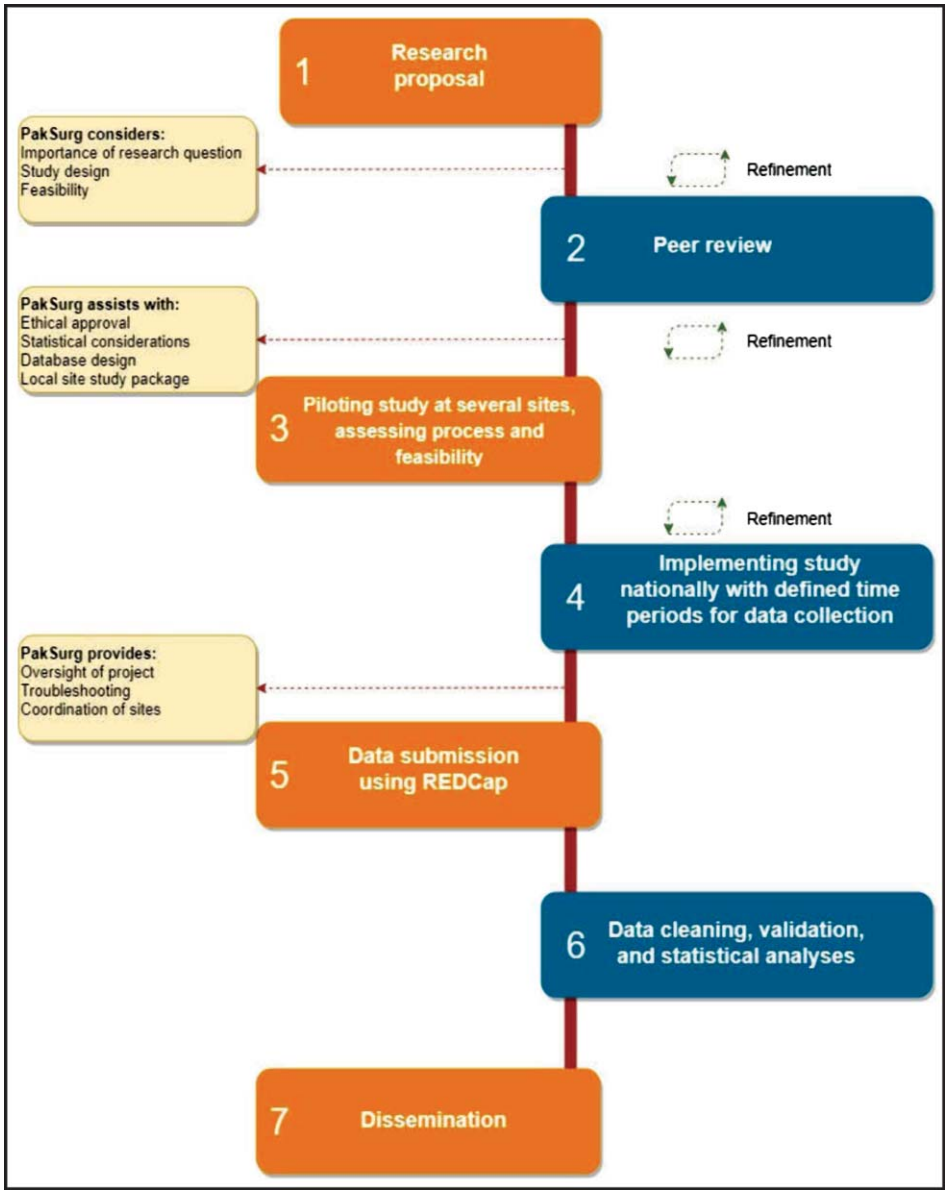

Figure-2: Study-management pathway incorporated into the PakSurg collaborative.

manuscript writing, and dissemination. All collaborators contributing data to the studies are awarded with PubMed indexed collaborator authorship on resulting publications, similar to global collaborative models.[20]

Conclusion

The organization of a successful multicentre research collaboration is challenging. A functional and cohesive team is required for the study planning and execution, with quality assurance. Although organization of such projects may be difficult, multicenter research provides evidence-based data related to safety and efficacy of surgical care.[21] Improvements in surgical outcomes in Pakistan warrants nationally representative data to inform evidence-based surgical care. Trainee-led surgical research collaboratives can fill this gap while ensuring that the research output is methodologically robust.

PakSurg Collaborative has been designed to involve a large number of trainees in data collection. This reduces burden on individual trainees while collectively leading to large, well-powered studies aiming to answer questions that would otherwise be difficult to answer.[6] In addition, PakSurg aims to increase surgical research output in Pakistan and provide evidence to improve patient care and health outcomes. Despite the potential of this strategy, this collaborative model is currently limited to observational studies due to governance issues associated with complex interventional studies. The PakSurg team plans to start with simpler studies and gradually progress to national, multicenter randomized controlled trials.

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