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SUCCESS RATE OF CROWNS AND FIXED PARTIAL DENTURES PROVIDED TO PATIENTS AT THE SCHOOL OF DENTAL SCIENCES, UNIVERSITY OF NAIROBI.
Dr Laura Gwahalla Edalia, BDS(Nbi)Tutorial Fellow, Department of Conservative and Prosthetic Dentistry, School of Dental Sciences, University of Nairobi, P.O Box 2032-00202, Nairobi, Bishar Alasow Kassim, BDS (Nbi), MDS (Nbi), Lecturer, Department of Conservative and Prosthetic Dentistry, School of Dental Sciences, University of Nairobi, Dr Fred Otieno, BDS (Nbi), Msc (UK), Lecturer, Department of Conservative and Prosthetic Dentistry, School of Dental Sciences, University of Nairobi. P.O Box 19676-00202, Nairobi. Dr. Tom Dienya BDS,( Nbi) CIBRD,( KASADA) MDS(mal), FADI, Lecturer department of conservative and prosthetic dentistry, University of Nairobi,Dr. Regina James Mutave, BDS(Nbi) MRes,( UK),PGD,RM,(Nbi)PHD ( Nbi) senior Lecturer, department of periondotology,community and preventive dentistry School of Dental Sciences,P.O Box 19676-00202, Nairobi.

Corresponding Author: Dr Laura Gwahalla Edalia, BDS(Nbi)Tutorial Fellow, Department of Conservative and Prosthetic Dentistry, School of Dental Sciences, University of Nairobi, P.O Box 2032-00202, Nairobi. Email: lauraedalia2000@yahoo.com

# SUCCESS RATE OF CROWNS AND FIXED PARTIAL DENTURES PROVIDED TO PATIENTS AT THE SCHOOL OF DENTAL SCIENCES, UNIVERSITY OF NAIROBI.

L. G. Edalia, B. A. Kassim, F. Otieno, T. Dienya, and R. J. Mutave

## ABSTRACT

*Objective*: **To evaluate the success rate of crowns and conventional fixed partial dentures provided to patients at the School of Dental Sciences, University of Nairobi.**
*Design:* **Descriptive cross-sectional study.**
*Setting:* **School of Dental Sciences, University of Nairobi.**
*Subjects*: **97 patients (35 male, 62 female) who had been provided with a total of 150 prostheses at the School of Dental Sciences between 2009 and 2015.**
*Materials and Methods:* **An interviewer administered questionnaire was used to collect information on socio-demographic data, oral hygiene practices, pain/sensitivity associated with prosthesis, level of satisfaction with the prosthesis and frequency of dental visits. A clinical and radiographic evaluation was conducted for the crowns and fixed partial dentures.**
*Results:* **The success rate for Fixed Partial Dentures (FPDs) was 75.4% (95% CI: 54.88-95.85%). A statistically significant association was demonstrated between FPD design and success (Fisher's Exact Test = 8.194, p=0.018) and between the position of the fixed partial denture in the mouth and success ($X^2$= 6.596, p = 0.017). The success rate of crowns was 66.7% (95% CI: 48.89-84.45%). A significant association was demonstrated between the level of training of the clinician and the success of crowns ($X^2$ = 7.772, p= 0.009) and between length of service and the success of crowns (Fisher's exact test = 8.846, p=0.011).**
*Conclusion*: **The success rate for crowns and FPDs in our study was lower than the success rate reported in similar studies. Whereas the design and location of prosthesis in the mouth had a significant influence on the success of FPDs, the level of training of clinician and length of service had a significant influence on the success of crowns.**

## INTRODUCTION

Treatment decisions for patients requiring crowns and fixed partial dentures should be based on sound scientific evidence. This can be acquired from an evaluation of treatment outcomes on survival, successes, failures and complications of various treatment modalities.A variety of studies have reported on the success rate and survival of crowns and fixed partial dentures (FPDs). Pjetturson et al, 1 conducted a systematic review in which they established a higher 5-year survival for metal–ceramic crowns (95.6%) as compared to that of all ceramic crowns (93.3%).

Survival in this study was defined as the crown remaining in situ with or without modification during the entire observation period. The mean follow-up time for the metal-ceramic crowns and the all ceramic crowns was 9.2 and 4.9 years respectively. One study on metal-ceramic crowns included in the review reported that anterior crowns had significantly higher retreatment needs.2 The 5 year survival rate of 95.6% reported by Pjetturson et al, 1 compared well with results from another systematic review which reported an estimated 5 year survival rate of metal-ceramic single crowns (SC) as between 94.1–96.9% and that of all ceramic crowns as between 94.7 – 96.6%.

3 Numerous studies evaluating fixed partial dentures have been conducted in dental schools and teaching hospitals.4, 5, 6 Cheung et al, 4 conducted a clinical evaluation of bridges at Prince Philip Dental Hospital in Hong Kong. In this seven-year retrospective study, 35 (20.7%) bridges out of 169 failed and had to be replaced. The most frequent cause of failure was need for endodontic treatment, followed by loss of retention, then persistent pain and sensitivity.

In a 15-year retrospective study at The Dental School, University of Oslo, Norway, 26 (24.1%) out of a total of 108 bridges were considered to have failed. Failed bridges were those which had been lost or had to be reconstructed due to failure.5 Insufficient retention, caries and esthetics were the commonest reasons for failures. A retrospective study conducted in a dental school at the Hebrew University, Jerusalem established a comparatively lower failure rate of 6% for fixed partial dentures.

The fixed partial dentures evaluated had an average lifespan of 6.3 years.6Caries was found to be the most frequent cause of failure. Non-vital abutments and abutments restored with post and cores contributed significantly to the failures. Though crowns and fixed partial dentures (FPDs) have been provided to patients at the School of Dental Sciences, University of Nairobi (UON) for many years, no critical evaluation of the outcomes of this treatment has been done.

There also seems to be a paucity of data on the same from clinical set-ups within the African continent. Knowledge from such studies will provide scientific evidence that will inform treatment planning and patient education for decision making in future. It is also hoped that knowledge of the causes of failure will help minimize their occurrence during critical stages of treatment.

Hence the purpose of this study was to evaluate crowns and tooth supported fixed partial dentures provided to patients over a period of seven years at the School of Dental Sciences, with the aim of establishing their success rate and factors that could have influenced their success.

## MATERIALS AND METHODS

This was a descriptive cross sectional study, conducted at the School of Dental Sciences, University of Nairobi. The study population comprised of patients who had received crowns and tooth supported fixed partial dentures at the School of Dental Sciences between 2009 and 2015. Ethical clearance was obtained from the Kenyatta National Hospital/ University of Nairobi Ethics and Research Committee (KNH-ERC/A/466). A list of patients who had been provided with crowns and fixed partial dentures between 2009 and 2015 was obtained by searching the school records manually.

All patients who had been provided with crowns or fixed partial dentures within the stated period and whose treatment records were available were eligible for the study upon providing informed consent. A total of 208 patients who satisfied the criteria for inclusion in this study were identified.

Their phone numbers were retrieved from these records and attempts were made to contact each of them. Twenty-nine of these patients could not be reached as their numbers were out of service or currently belonged to other persons. Out of 179 patients who were contacted and invited for a review appointment, 97(54%) responded positively, the rest were not able to avail themselves for review due to numerous reasons. The 97 patients all signed an informed consent form and were included in the study.

An interviewer administered questionnaire was used to collect information on socio-demographic data, oral hygiene practices, pain/sensitivity associated with prosthesis and frequency of dental visits. The first author who was the principal investigator administered the questionnaire to all the participants. Clinical examination was done in a conventional dental chair with good lighting.

The principal investigator conducted the examination using dental mirrors, explorers and periodontal probes. The principal investigator had undergone calibration by the second author. Two trained research assistants recorded the information, these were dental students who had been trained and calibrated by the principal investigator. The following details were recorded regarding the crowns and fixed partial dentures: Location, design, span of fixed partial dentures and materials used for fabrication. Information regarding the length of service, types of posts utilized, type of luting cement utilized for cementing posts, crowns and fixed partial dentures was gathered from patients' notes on file.

The California Dental Association (CDA) criteria, 7 was used to evaluate the quality of the crowns and fixed partial dentures. Using this criteria the surface characteristics, colour, anatomic form and marginal integrity was evaluated and the prostheses were classified as excellent, acceptable, 'to be corrected' or 'to be replaced'. All the prostheses placed in the category of 'range of excellence' and 'range of acceptability' were deemed successful whereas those that were placed in the category of 'correct for prevention' and 'replace statim' were deemed as failures.

Plaque score values were recorded using Turesky's modification of Quigley and Hein plaque index, 1970.8 Gingival health of crowned and abutment teeth was evaluated by use of Loe and Silness gingival index. 9 Radiographic examination was conducted for all the teeth with single crowns and all the abutment teeth for fixed partial dentures. Intra-oral periapical radiographs were taken using the bisecting angle technique. The radiographs were taken by the principal investigator and processed by the research assistants using an automatic processor. The radiographs were analysed on an x-ray viewer by the principal investigator.

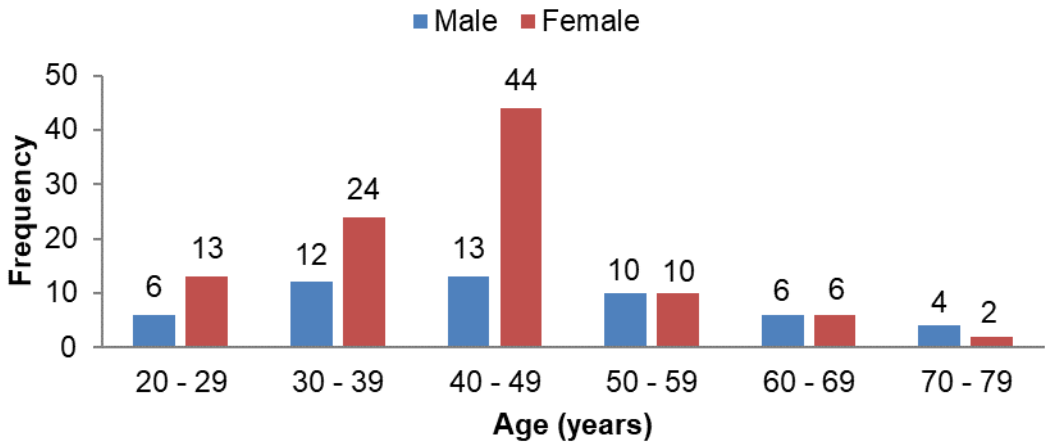
They were analysed for evidence of radiolucency consistent with caries, widening of periodontal ligament (pdl) space, presence of root filling, presence of posts and presence of periapical pathology in crowned/abutment teeth. For the cases which presented with periapical radiolucency, comparison was done with pre-operative radiographs retrieved from the patient's file.

## RESULTS

The data collected was analyzed using the statistical package for social sciences (SPSS v.21, IBM) for Windows and Microsoft excel. Basic descriptive statistics were performed. Chi square test and Fisher's exact test were performed to identify associations between different variables. The level of significance was set at 0.05. A total of 97 patients attended the review appointment. These patients had been provided with a total of 150 prostheses (81 crowns, 69 FPDs). The patients ranged from 23 to 76 years of age, averaging 44.65( ± 12.61 SD) years of age. Thirty five (36.1%) were male and 62 (63.9%) were female (Figure 1).

**Figure 1**

*Age and gender distribution*




**Distribution of crowns and fixed partial dentures**

The patients evaluated had been provided with a total of 69 fixed partial dentures and 81 crowns. A total of 66 (44%) prostheses were located in the anterior aspect whereas 84 (56%) were located posteriorly (Table 1).

**Table 1**

*Distribution of crowns and fixed partial dentures in patients in the study population*

| Type of prostheses | Anterior n (%) | Posterior n (%) | Total |
|---|---|---|---|
| Crown | 43 (53.1%) | 38 (46.9%) | 81 |
| FPD | 23 (33.3%) | 46 (66.7%) | 69 |
| Overall | 66 (44.0%) | 84 (56.0%) | 150 |

Graduate students provided more prostheses as compared to undergraduate students and interns (Table 2).

**Table 2**
*Level of training of clinicians who provided crowns and fixed partial dentures*

| Type of restoration | Undergraduate n (%) | Graduate n (%) | Intern n (%) | Total |
|---|---|---|---|---|
| Crown | 23 (28.4%) | 54(66.7%) | 4(4.9%) | 81 |
| FPD | 14(20.3%) | 55(79.7%) | 0 | 69 |
| Overall | 37(24.6%) | 109(72.7%) | 4(2.7%) | 150 |

Length of service was defined as the lifetime of FPDs and crown units from cementation up to the time of examination or failure.

The mean length of service for crowns was 35.94 (± 20.05 SD) months, the shortest length of service was 8 months whereas the longest was 80 months. For the FPDs, the mean length of service was 42.79(± 22.25 SD) months, the shortest length of service was 6 months whereas the longest was 84 months. This was recorded only for restorations that were present at the time of examination because length of service for missing restorations could not be accurately determined.

*Fixed Partial Dentures*

A total of 69 FPDs containing 241 units had been provided to patients within the study period. Of these 143(59.3%) were abutments and 98(40.7%) were pontics. Most of the FPDs were three unit and four unit FPDs accounting for 40(58%) and 18(26.1%) FPDs respectively (Figure 2).

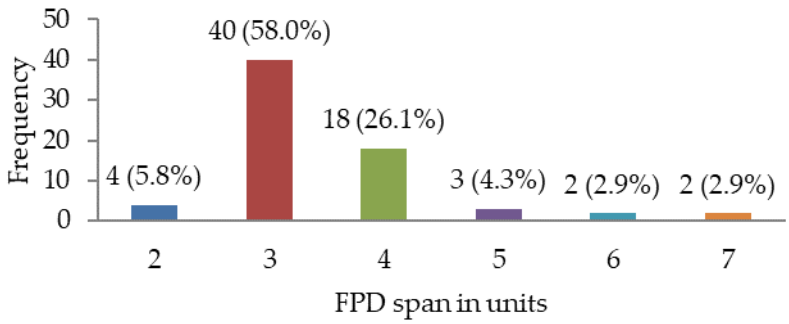



**Figure 2**
*FPD span distribution*

Fifty-nine (85.5%) fixed partial dentures were of the fixed-fixed design, while 7(10.2%) were of cantilever design and 3(4.4%) were resin bonded bridges. Two of the cantilever FPDs were modified designs with the presence of a rest. There were no FPDs evaluated which had utilized the fixed movable design. Metal-ceramic was the most common material used to fabricate FPDs accounting for 68(98.6%) prostheses. One (1.4%) FPD was fabricated by use of heat cured acrylic whereas none were fabricated using all ceramic materials. At the time of evaluation, one FPD had been replaced and two were missing, thus a total of 66 FPDs containing 137 abutments were assessed. A total of 61(92.4%) FPDs were found to be within the range of excellence or acceptability

for colour and surface characteristics, 63 (95.4%) FPDs for anatomic form and 54(81.8%) FPDs for marginal integrity (Table 3). Some of the failed prostheses were unacceptable in more than one category.

**Table 3**

*Results for evaluation of fixed partial dentures using CDA criteria*

| Characteristic | Range of excellence | Range of acceptability | Correct for prevention | Replace statim | Total |
|---|---|---|---|---|---|
| | n (%) | n (%) | n (%) | n (%) | |
| Surface and colour | 23(34.8%) | 38(57.6%) | 1(1.5%) | 4(6.1%) | 66 |
| Anatomic form | 21(31.8%) | 42(63.7%) | 1(1.5%) | 2(3.0%) | 66 |
| Marginal Integrity | 20(30.3%) | 34(51.5%) | 8(12.1%) | 4(6.1%) | 66 |

The periodontal health evaluation was done for 137 abutments. Twenty-seven (19.7%) teeth had no signs of gingivitis. Seventy-five (57.3%) of the abutment teeth had signs of moderate gingivitis, while 31(22.6%) and 4(2.9%) had signs of mild and severe gingivitis respectively. A total number of 137 abutment teeth were evaluated radiographically. Two (1.4%) of the FPD abutments exhibited evidence of decay whereas periapical radiolucency was evident in 6(4.4%) teeth.

Out of the six teeth with periapical radiolucency, 4 were endodontically treated and on comparison with previous radiographs it was noted that this radiolucency was resolving, however two of the teeth were not endodontically treated and this was regarded as evidence of loss of vitality. Abutments that were endodontically treated accounted for 40(29.2%) of the total number of abutments, 16 (11.7%) of these had been restored with posts. Upon clinical and radiographic evaluation, 52 (75.4%) FPDs were considered successful whereas 14(20.3%) were indicated for replacement.

The success rate was therefore determined as 75.4 %( 95% CI: 54.88-95.85%). Defective margins and porcelain fractures were the leading causes for need of replacement affecting 12(18.2%) and 6(9%) FPDs respectively. Several prostheses were indicated for replacement due to more than one reason. The average length of service for the failed bridges was 40.21(±29.71) months. A statistically significant association was demonstrated between FPD design and success (Fisher's Exact Test = 8.194, p=0.018). Cantilever design demonstrated the lowest success rate.

Chi square test demonstrated a statistically significant association between position of the FPD in the mouth and success ($\chi 2$= 6.596, p= 0.017). Posterior FPDs had a higher success rate when compared to the anterior ones. There was no statistically significant association between length of service, presence of root filling on abutments, span of prostheses, presence of posts, level of clinician's training and success of FPDs.

*CROWNS*

A total of 81 crowns had been provided to patients participating in the study. Upper incisors were the most commonly crowned teeth accounting for 39 (48.1%) of the crowned teeth. Upper premolars and lower molars were also frequently crowned accounting for 17(21%) and 13(16%) of the crowned teeth respectively (Table 4).

***Table 4***
*Distribution of crowns according to type of teeth crowned*

| Tooth type | n (%) |
|---|---|
| Maxillary incisors | 39(48.1%) |
| Maxillary canines | 2(2.5%) |
| Maxillary premolars | 17(21%) |
| Maxillary molars | 5(6.2%) |
| Mandibular incisors | 2(2.5%) |
| Mandibular canines | 0(0%) |
| Mandibular premolars | 3(3.7%) |
| Mandibular molars | 13(16%) |

Seventy-eight (96.3%) of the crowns had been fabricated from metal-ceramic materials while 3(3.7%) had been fabricated by use of all ceramic materials. Thirteen (14.6%) crowns were either missing or were found to have been replaced at the time of examination, hence a total of 68 crowns were evaluated. Using the CDA criteria, a total of 63(92.6%) crowns were found to be within the range of excellence or acceptability for colour and surface characteristics, 60 (88.2%) crowns for anatomic form and 59 (86.7%) crowns for marginal integrity. Some of the failed crowns were unacceptable in more than one category (Table 5).

**Table 5**
Results for evaluation of crowns using CDA criteria

| Characteristic | Range of excellence | Range of acceptability | Correct for prevention | Replace statim | Total |
|---|---|---|---|---|---|
| | n (%) | n (%) | (n %) | n (%) | |
| Surface characteristic and colour | 16(23.5%) | 47(69.1%) | 0 | 5(7.4%) | 68 |
| Anatomic form | 16(23.5%) | 44(64.7%) | 5(7.4%) | 3(4.4%) | 68 |
| Marginal Integrity | 16(23.5%) | 43(63.2%) | 6(8.8%) | 3(4.4%) | 68 |

Forty-seven teeth (69.1%) exhibited signs of moderate gingivitis, 12(17.7%) exhibited signs of mild gingivitis while 9 (13.2%) had healthy gingiva with no signs of inflammation. There were no teeth which had severe gingivitis. Sixty-eight crowned teeth were evaluated radiographically. One (1.5%) of the crowned teeth exhibited evidence of decay whereas 7 (10.3%) exhibited periapical radiolucency.

All the 7 teeth exhibiting periapical radiolucency had been root treated and on comparison with previous radiographs it was noted that this radiolucency was resolving in all the cases. A total of 56 (82.4%) crowned teeth were endodontically treated. Of these, 36(52.9%) had been restored with posts. Upon clinical and radiographic assessment, 54 (66.7%) crowns were considered successful. The success rate was determined as 66.7% (95% CI: 48.89-84.45%). Fourteen (17.3%) crowns were deemed unacceptable hence to be replaced; defective margins and porcelain fractures were the most common causes of failure accounting for 9(64.3%) and 4(28.6%) of the failed crowns respectively. Caries, loss of retention and poor esthetics were the other causes of failure. The average length of service for the failed crowns was 46.93 (+26.04) months. Table 6 summarizes the causes of failure for both crowns and FPDs.

***Table 6***
*Causes of failure for crowns and FPDs*

| Cause of failure | FPDs n (%) | Crowns n (%) |
|---|---|---|
| Defective margins | 12(17.6%) | 9(13.6%) |
| Porcelain fracture | 6(8.8%) | 4(6.1%) |
| Caries | 2(2.9%) | 1(1.5%) |
| Decemented rest | 2(2.9%) | - |
| Loss of vitality | 2(2.9%) | - |
| Loss of retention | - | 1(1.5%) |
| Poor esthetics | - | 1(1.5%) |

A statistically significant association was demonstrated between length of service and the success of crowns (Fisher's exact test = 8.846, p=0.011).

The crowns which had served for a longer period exhibited a lower success rate. There was also a significant association between the level of training of the clinician and the success of crowns ($\chi 2$ (1) =7.772, p= 0.009). Crowns fabricated by graduate students had a higher success rate as compared to those fabricated by undergraduate students and interns. Chi square test yielded no association between the presence of root fillings, presence of posts, position of crown and the success of crowns.

## DISCUSSION

The success rate for crowns in our study was 66.7% for a mean length of service of 35 months. This was much lower than the success rate reported for metal-ceramic crowns in two systematic reviews (95%).[1, 3]For FPDs the success rate was 75.4% for a mean length of service of 43 months. This translated to a failure rate of 24.6%. This was comparable to the failure rate reported by Cheung et al which was 20.7% for a mean length of service of 35 months.[4] However, it was much higher than the failure rate reported in several other studies.[5, 6, 10] Vaulderhaug et al, 5 conducted a 15-year prospective study and reported failure rates of 4%, 12% and 32% after 5, 10 and 15 years respectively.

Hochman et al, [6]reported a failure rate of 6% for a mean lifespan of 6.3 years whereas Libby et al, [10] reported a failure rate of 15% for a mean length of service of 16 years. These differences may be partly attributed to the differences in definition of success and failure and different methods of evaluation encountered across various studies. Whereas in our study crowns and FPDs that were found to be in service but recommended for replacement were deemed as failures, in some studies FPDs were only regarded as failures if they had been lost or replaced.[11]

The fact that this was a retrospective study conducted in a set-up without a proper recall system may also have contributed to the recording of a high failure rate because patients with problematic prostheses were more likely to show up for the evaluation as compared to those whose prostheses were not problematic. The response rate in this

study was 54%, indicating that a significant number of patients did not show up for the evaluation. The choice of material for crowns and FPDs may also have contributed to a higher failure rate. Most of the crowns (96.3%) and FPDs (98.6%) were fabricated from metal-ceramic materials. The alloy utilized for all the cases were base metal alloys. When compared to precious metals these alloys have been shown to have increased problems with casting accuracy, castability and porcelain-alloy compatibility.[12] These challenges may have contributed to the large number of defective margins and porcelain fractures encountered in this study affecting a total of 21 (15.7%) and 10(7.5%) prostheses respectively. These results can be contrasted with those of Libby et al, [10] which reported only one failure out of 89 FPDs as a result of porcelain fracture with a mean length of service of 16 years.

They attributed this impressive record to the use of high content gold alloys for the metal-ceramic restorations. The fixed-fixed design was utilized in most of the FPDs accounting for 59(85.5%) of the cases. This design is favored because force that is applied to the pontic is distributed equally to the abutment teeth.[13] Design of FPDs was shown to have a statistically significant influence on success rate (Fisher's Exact Test = 8.194, p=0.018). Cantilever design demonstrated the highest failure rate with 5(71.4%) out of the 7 FPDs with this design having failed. In as much as the use of this design is justifiable in some clinical situations, it is considered potentially destructive due to the lever arm created by the pontic and whenever it is used it must be well designed to minimize damage to the abutment teeth.[13] .

The fact that this design is potentially destructive provides an explanation as to why the design was not commonly utilized in the study population. Non-vital teeth have been shown to exert a negative influence on the success and survival of crowned teeth and FPD abutments.[6, 14] In this study, higher failure rates were recorded for non-vital crowned teeth and FPDs with non-vital abutments, however the differences were not statistically significant (Fisher's Exact Test = 0.738, p = 0.531, Fisher's Exact Test =2.300, p = 0.143).

Porcelain-fused-to-metal (PFM) has for a long time been considered the gold standard for fabrication of prostheses due to its ability to combine good mechanical properties with acceptable esthetic results, and ability to provide biological quality needed for periodontal health.1 This perhaps explains why it was the material of choice for 78(96.3%) crowns and 68(98.6%) FPDs in this study. One of the major limitations associated with PFM prostheses is an esthetic limitation that arises due to the presence of underlying metal beneath the porcelain and the layer of opaque porcelain which is usually necessary to mask the underlying grayish shade from the metal.

This usually results in a restoration that lacks translucency usually associated with natural teeth. This may be part of the reason why 47(69.1%) of the crowns and 38(57.6%) of the FPDs in this study were rated as acceptable in the surface and colour category using the CDA criteria, where 'acceptable' denoted slight shade disharmony with the adjacent tooth that was clinically acceptable. This esthetic limitation associated with metal-ceramic restorations has resulted in increased popularity of all ceramic restorations in the recent times.

All ceramic restorations confer excellent esthetics, however their main drawback is brittleness and susceptibility to fracture when

subjected to high loads. Studies have shown reduced survival rate for all ceramic FPDs,15 this and the fact that long term studies on the same are limited could have contributed to the lack of utilization of all ceramic bridges in the study population. However, despite studies having shown high short term and mid-term survival rates for all ceramic crowns,15 their utilization was very low. Financial implications might have played a role as the all ceramic prostheses are more costly as compared to the metal-ceramic ones, limited availability of processing equipment may also have been a contributing factor. Further research may be necessary to look into the factors that may have contributed to the low uptake of all ceramic restorations within the institution. Institution of measures to improve the outcomes of crowns and FPDs provided to patients at the School is recommended.

## CONCLUSION

1. The success rate for FPDs determined as 75.4% (95% CI: 54.88-95.85%) and that for crowns determined as 66.7%(95% CI: 48.89-84.45%) was lower than that reported in similar studies.
2. The position and design of FPDs had an influence on the success rate with anterior FPDs and cantilever design exhibiting lower success rates.
3. The level of training of the clinician and length of service had an influence on the success rate of the crowns, those fabricated by graduate students and those that had served for a shorter period had a higher success rate.
4. Non vital abutments and non-vital crowned teeth did not have a negative influence on the success rate of crowns and fixed partial dentures.

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