

ORIGINAL RESEARCH

Evaluation of choice of crowns in patients undergoing fixed partial dentures: an original research

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ABSTRACT

Introduction: Fixed partial dentures (FPDs) have a high survival rate, however they are often associated with biological and technical complications. Crowns may be utilized to improve appearance of discolored or malformed teeth. They are also utilized to confer protection and to restore form and function to teeth which may be compromised due to loss of tooth structure. The loss of tooth structure may occur due to caries, endodontic procedures, erosion, abrasion, attrition or trauma. Crowns are also indicated as retainers for fixed partial dentures. A fixed partial denture (FPD) is a dental prosthesis that is luted to natural teeth or dental implant abutments for primary support

Objective: To evaluate the choice of crowns in patients undergoing fixed partial dentures. This was a descriptive cross sectional study. The study sample comprised of patients who had received crowns and fixed partial dentures between the year 2011 and 2016.

Materials and methods: A close ended 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, frequency of dental visits and presence of systemic illnesses. Clinical examination was conducted to evaluate the quality of crowns and FPDs using the California Dental Association (CDA) criteria where prostheses were classified as 'excellent', 'acceptable', 'to be corrected' or 'to be replaced'. The periodontal health of crowned and abutment teeth was evaluated by measurement of gingival scores, periodontal attachment loss, periodontal probing depth and mobility. The crowned teeth and FPD abutments were radiographically evaluated for presence of dental caries, periapical radiolucency, widening of the periodontal ligament space, root filling, intracanal posts and bone loss.

Results: Sensitivity to thermal stimuli, porcelain fractures and defective margins were the most common complications associated with FPDs. The success rate for FPDs was 65.3%.

Conclusion: The success rate for FPDs determined as 65.3% and that for crowns determined as 56.7% was lower than the success rate reported in other studies. The position and design of FPDs had a significant influence on the success rate whereas the level of training of the clinician and length of service had a significant influence on the success rate of the crowns. Porcelain fractures, defective margins and loss of retention were the most common complications associated with both crowns and fixed partial dentures, additionally sensitivity was common among fixed partial dentures.

INTRODUCTION

A crown has been described as an artificial replacement that restores missing tooth structure by surrounding part or all of the remaining natural tooth structure with a material; this material may be ceramic, cast metal or a combination of materials such as metal and ceramic¹. Crowns may be utilized to improve appearance of discolored or malformed teeth. They are also utilized to confer protection and to restore form and function to teeth which may be compromised due to loss of tooth structure. The loss of tooth structure may occur due to caries, endodontic procedures, erosion, abrasion, attrition or trauma. Crowns are also indicated as retainers for fixed partial dentures. A fixed partial denture (FPD) is a dental prosthesis that is luted to natural teeth or dental implant abutments for primary support. These prostheses are useful in replacement of missing teeth. Tooth loss is a common problem affecting patients seeking dental rehabilitation. Research conducted to assess the global burden of severe tooth loss revealed that 158 million people translating to 2.3% of the global population was edentate in 2010². Kenya being a developing country with limited economic and human health resource is likely to report a much higher figure of edentate patients. Tooth loss most commonly occurs as a result of untreated dental caries and advanced periodontal disease. Trauma arising from road traffic accidents, falls, sporting accidents and interpersonal violence may also result in tooth loss. Some patients may present with congenitally missing teeth. Most patients often require replacement of missing teeth to improve their appearance and/or their masticatory efficiency. Ideally, treatment decisions for patients requiring crowns and fixed partial dentures should be based on sound scientific evidence, treatment needs and desires of the patient, clinical factors in the oral cavity, the patient's economic circumstances and expertise available. Sound scientific evidence can be acquired from an evaluation of treatment outcomes which will reveal survival, successes, failures and complications of various treatment modalities³. Several complications may arise related to crown and fixed partial denture work⁴. These include biological, mechanical and aesthetic complications which if unattended may lead to eventual loss of the prosthesis and the abutment teeth. Although crowns and fixed partial dentures (FPDs) have been provided to patients for many years, no critical evaluation of the outcomes of this treatment has been done. Such an evaluation is critical for quality control purposes and as part of research that influences treatment planning and decision making. The purpose of this study was to evaluate the crowns and tooth supported fixed partial dentures provided to patients over a period of six years with the aim of establishing their success rate, associated complications and factors that could have influenced their success. A full veneer crown is a restoration that replaces lost tooth structure and imparts some degree of structural support to the tooth. Crowns are considered the most retentive of veneer preparations and are therefore indicated for use on teeth whose restoration demands maximum retention⁵. Crowns may be all-metallic, metal-ceramic or all ceramic. The preparation for a full metal crown is less invasive than those required for either metal-ceramic or all ceramic crowns, however these types of crowns are

unaesthetic⁶. All ceramic crowns are capable of producing superior cosmetic results when compared to other dental restorations, their main limitation being susceptibility to fracture as ceramic is brittle⁷. Metal ceramic restorations consist of a thin cast metal coping that is layered with ceramic. This combines the strength and accurate fit of cast metal with superior esthetics of a ceramic crown. Friedlander⁸ et al, found these metal-ceramic restorations to be 2.8 times stronger than all ceramic restorations. Documented reasons for placement of single crowns include failed restorations, tooth fracture, discolored teeth, wear, endodontic reasons, occlusal problems among others⁹. In one study which evaluated reasons for crown placement and replacement; tooth fracture, restoration failure and esthetics were the most common reasons for initial crown placement. Upper premolars were the most common teeth receiving initial crown placement accounting for 24%, followed by lower molars (22%) and upper incisors (19%). Upper second premolars were more commonly crowned as compared to the upper first premolars¹⁰. In badly broken down endodontically treated teeth, crown retention is usually provided by a core which in turn gets retention from an intracanal post. Intracanal posts may be prefabricated or custom made with the latter being cast in metal. The prefabricated ones maybe made of metal, ceramic or resin reinforced with either carbon or glass fibre. Various designs exist, the posts may be tapered or parallel. Parallel posts are more retentive however they result in more destruction of tooth structure whereas tapered posts are more conservative since they conform to the root canal morphology¹¹. Tapered posts may concentrate forces apically with a resultant wedging effect on the tooth being restored, hence they are associated with a higher risk of root fracture. The surface of posts may be smooth, serrated or threaded. A systematic analysis of various outcome studies evaluating fixed tooth restorations highlighted varying descriptions of survival and success from various studies. Fradeani & Redemagni described survival of crowns as the period between cementation and the time which the crown was shown to have failed irreparably¹². In another study, it was simply described as “Crown not removed”. Similarly, varying descriptions of success were established where one study described success as those crowns that were present without core fracture, porcelain fracture, caries, sign of periodontal inflammation (specifically bleeding on probing), or endodontic signs and symptoms. Another definition of success from a different study was the presence of restorations still in clinical service. Pjeturson¹³ et al, 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. The all ceramic crowns included in the study were the glass infiltrated alumina, glass ceramics, reinforced glass ceramics and densely sintered alumina crowns. The failure rates for posterior crowns was higher than that for anterior crowns for all the ceramic material types whereas for the metal-ceramic crowns the difference in failure rates between anterior and posterior teeth was not statistically significant. One study on metal-ceramic crowns included in the review reported that anterior crowns had significantly higher retreatment needs¹⁴. The survival rates reported by Pjeturson¹³ et al, 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%. Many teeth will require full coverage crowns following endodontic treatment. Endodontically treated teeth have been shown to have shorter survival times when compared to vital teeth, this has been attributed to compromised structural integrity due to caries, endodontic procedures, trauma, and preparation procedures for restorations. Many times restoration of these teeth involves use of intracanal posts to augment retention of the core prior to crowning¹⁵.

MATERIAL AND METHODS

This was a descriptive cross sectional study. The study population comprised of patients who had received crowns and tooth supported fixed partial dentures between 2011 and 2016. This was influenced by availability of records for crowns and fixed partial dentures provided to patients. Data collection commenced at the beginning of 2016. Sample size determination was calculated using Fisher's method of sample size determination. Based on a study evaluating the complications of fixed prosthodontics the prevalence of complications associated with fixed partial dentures was 30%. Hence purposive sampling method was utilized. Patients who had been provided with crowns and FPDs in the stated period were identified from the clinical work registration book and contacted by phone. All patients who responded and showed up for evaluation were included in the study upon satisfying the consenting procedures. A list of patients who had been provided with crowns and fixed partial dentures between 2011 and 2016 was obtained by searching the records manually. A total of 108 patients satisfying 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 five of these patients could not be reached as their numbers were out of service or had changed ownership. Out of 83 patients who were contacted and invited for a review appointment, 77 responded positively, the rest were not able to avail themselves for review due to various reasons. These reasons included relocation, busy work schedules and failure to honour appointments without explanation. The patients were called for review on specific days designated for the study. Each patient was given an appointment and allocated an hour for the process. On arrival, purpose of the study, risks and benefits were explained to the patient. All inquiries and concerns raised by the patient were addressed. The patient was then provided with the consent information document. Once certain that the patient had read and understood all the information contained in the document, if they agreed to participate in the study they were requested to sign the consent form. They were reassured that the information obtained would be treated with confidentiality and that they were to be honest with their answers without fear of negative repercussions. They were also given the liberty to decline participation without any dire consequences. An interviewer-administered questionnaire was used to gather information on socio- demographic data, oral hygiene practices, pain/sensitivity associated with prosthesis, level of satisfaction with the prosthesis, frequency of dental visits and systemic illnesses. This questionnaire was administered by the principal investigator. Clinical examination was done in a conventional dental chair in the presence of good lighting. All the patients were examined by the principal investigator while research assistants did the recording. Two research assistants were involved in the study, they were undergraduate dental students who had been trained and calibrated by the principal investigator. The intra-oral examination was conducted by use of dental mirrors, explorers and periodontal probes. All the instruments used had been sterilized using standard procedure. The following details were recorded in the data collection form regarding the crowns and fixed partial dentures: Location of prosthesis (anterior/posterior), prosthesis type, prosthesis design and span of fixed partial dentures. The CDA criteria was used to evaluate the quality of the single crowns and fixed partial dentures. Using this criteria the surface characteristics, colour, anatomic form and marginal integrity was evaluated. All the prostheses placed in the category of 'range of excellence' and 'range of acceptability' were deemed acceptable whereas those that were placed in the category of 'correct for prevention' and 'replace statim' were deemed unacceptable. Intra-oral photographs of the prostheses were taken. Oral hygiene status was evaluated by use of plaque score values. Each patient was provided with a plaque disclosing tablet and instructed to crush it and spread it on all the

teeth surfaces. Plaque score values were recorded using Turesky's modification of Quigley and Hein plaque index, 1970(Appendix VIII). The periodontal status of the abutment teeth and teeth with single crowns was evaluated by assessment of gingival score, probing pocket depths, periodontal attachment levels and tooth mobility. Loe and Silness gingival index, 1963 was utilized for grading of the gingival score (Appendix IX). The number of carious, missing and filled teeth for each patient was recorded. 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 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 to establish whether it was a new lesion or an old lesion that was either resolving or increasing in size. Information on the presence of posts and type of posts used was confirmed from patient records. All the above information was captured in the data collection form (Appendix VI). Pretesting of the data collection instruments was done. The principal investigator was calibrated by the first supervisor to calculate inter-examiner variability in assessment of the prostheses and categorization as "acceptable" or "not acceptable". Patients whose prostheses were evaluated were not part of the study population. The prostheses were evaluated for colour, anatomic form and marginal integrity using the CDA criteria. Cohen's kappa was used to calculate inter-examiner reliability and a value of 0.81, 0.81 and 0.9 achieved for colour, anatomic form and marginal integrity respectively denoting an almost perfect agreement. Intra-examiner reliability in assessment of prostheses and categorization as "acceptable" or "not acceptable" was also evaluated. For every tenth participant, reassessment of their prostheses was done on a separate appointment scheduled two weeks after the initial examination by the principal investigator. The findings from the two separate examinations of the same prostheses were compared. Cohen's kappa was used to calculate intra-examiner reliability and a value of 0.9 was achieved for all three categories; colour, anatomic form and marginal integrity denoting an almost perfect agreement. The p-value for statistical significance was set at less than 0.05.

RESULTS

A total of 77 patients were examined. These patients had been provided with a total of 80 prostheses (60 crowns, 20 FPDs). The age of the patients ranged from 23 to 76 years, averaging (44.65 ± 12.61) years. 36.1% were male and 63.9% were female. The average age of males, (44.74 ± 13.94) years was higher than that of females, (42.60 ± 11.92) years, however the difference was not statistically significant [$t(95) = 0.055$, $p = 0.957$]. Seventy two (72.3%) participants had tertiary level of education while 18(18.6%) and 5(5.1%) had secondary and primary level of education respectively. Fifty two (52.7%) of them were employed while 34 (35.1%) were self-employed and 9(9.2%) were unemployed. Seventy six (76.3 %) participants reported that they brushed their teeth twice a day, while 23 (23.7%) brushed once a day. A total of (58.8%) reported use of dental floss for interdental cleaning while only 9 (9.3%) reported use of superfloss. The mean plaque score was $1.4(\pm 0.5 \text{ SD})$. There was no significant association between the level of education and frequency of brushing (Fisher's Exact Test = 1.748, $p = 0.401$)(Table 1). A Spearman's rank-order correlation coefficient showed a non-statistically significant association between frequency of brushing and plaque score. The success rate for FPDs determined as 65.3% and that for crowns determined as 56.7% was lower than the success rate reported in other studies.

Table 1: Gingival Score for crowned teeth

Gingival Score	N %
Healthy	9(13.2)
Mild Gingivitis	12(17.7)
Moderate Gingivitis	47(69.1)
Severe Gingivitis	0(0)

DISCUSSION

Majority of the FPDs consisted of three units and four units accounting for 84.1% of the FPDs. This is consistent with studies carried out in other dental clinics and among general dental practitioners. Hochman et al¹⁶ evaluated a total of 50 FPDs out of which 40% were three unit and 26% were four unit FPDs. Vaulderhaug¹⁷, evaluated 108 bridges out of which 59(54.6%) had between two and four units. Leempoel¹⁸ et al, collected data on 1674 bridges from among general dental practitioners, 1386(83%) consisted of three and four unit bridges. Long span bridges are generally not preferred due to complexity of preparation of these bridges, insufficient number of abutments and difficulty in maintenance by the patient. In this study 46 (66.7%) of the FPDs fabricated were located in the posterior region. It is generally recommended that FPDs should be limited to replacing two missing teeth in the posterior region in order to achieve adequate support from the adjacent teeth. This, and the fact that the prostheses were provided at a teaching institution, explains why the three unit and four unit FPDs were more prevalent. Our study did not demonstrate any association between the span of the FPDs and success; this correlates well with the findings of Walton¹⁹ et al, who did not find a relationship between the length of service and the span of prostheses. The fixed-fixed design was utilized in most of the FPDs accounting for 59(85.5%) of the cases. This design is favored because forces that are applied to the pontic are distributed equally to the abutment teeth. The fixed movable design was not utilized in any of the FPDs. This design is usually indicated where there is presence of a pier abutment. The movable joint acts as a stress breaker which minimizes mesio-distal torquing of the abutments while permitting them to move independently. Pier abutments will usually be present in long span edentulous spaces. The low number of long span bridges in this study provides an explanation why this design was not utilized. The design may also be indicated where a mesially tilted molar is utilized as an abutment to achieve different paths of insertion for the two abutments. The cantilever design accounted for 7(10.1%) of the cases. This design maybe utilized for conservation of tooth structure where preparation of one of the teeth adjacent to the edentulous space is spared or in instances where a distal abutment is missing. 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 teeth²⁰. The fact that this design is potentially destructive provides an explanation as to why the design was not commonly utilized. Cantilever bridges in this study demonstrated a very high failure rate with 5(71.4%) out of the 7 FPDs with this design having failed. The design is also less retentive when compared to a fixed-fixed FPD. One of the FPDs with this design had been lost due to lack of retention. Two FPDs in this category whose design had been modified to incorporate a rest on the adjacent teeth to minimize torquing forces on the abutment had presented with decemented rests. This necessitated replacement to prevent occurrence of decay underneath the decemented rests. The tendency of the rests to decement suggests that this design is not favourable since it often necessitates replacement of the prostheses and if undetected may result in caries in a tooth that was otherwise healthy. 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 health²¹. This perhaps explains why it was the material of choice for crowns and FPDs in this study. However, 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 and may compromise the overall esthetic result. 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 crowns in a similar study conducted in dental college which was 92% for a mean lifespan of 75 months. The success rate for FPDs in our study was 75.3% for a mean length of service of 43 months. This translated to a failure rate of 24.7%. This was comparable to the failure rate reported by Cheung²² et al which was 20.7% for a mean length of service of 35 months. However it was much higher than the failure rate reported in several other studies. Hochman¹⁶ et al, reported a failure rate of 6% for a mean lifespan of 6.3 years whereas Libby²³ et al, reported a failure rate of 15% for a mean length of service of 16 years. Vaulderhaug²⁴ et al, conducted a 15 year prospective study and reported failure rates of 4%, 12% and 32% after 5, 10 and 15 years respectively. These differences may be partly attributed to the differences in definition of success and failure encountered across various studies. Whereas in our study FPDs that were found to be in service but recommended for replacement were deemed as failures, in a similar study FPDs were only regarded as failures if they had been lost or replaced. Vaulderhaug²⁴ et al, conducted a longitudinal study in which they evaluated the periodontal conditions in patients with bridges. In their findings they reported that the gingiva of crowned teeth was more commonly inflamed as compared to that of control teeth. These crowned teeth more frequently registered a GI score of 2 and 3 as compared to the control teeth. A slight increase in mean pocket depth was also recorded in the crowned teeth during the observation period. Similarly, in this study 47(69%) crowned teeth and 75(54.8%) FPD abutments had a GI score of 2 while 4(2.9%) FPD abutments had a GI score of 3. This is not surprising since crowns and FPDs abutment have been shown to harbour increased plaque accumulation with resultant gingival inflammation and pocket formation. However, the state of the periodontium could not be solely attributed to the presence of crowns and FPDs since no values for control teeth were recorded.

CONCLUSION

The success rate for FPDs determined and that for crowns determined was lower than that reported in similar studies. The position and design of FPDs had an influence on the success rate with anterior FPDs and cantilever design exhibiting lower success rates. 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 duration had higher success rates. Non vital abutments and non vital crowned teeth did not have a negative influence on the success rate of crowns and fixed partial dentures. Porcelain fractures, defective margins and loss of retention were the most common complications associated with both crowns and fixed partial dentures, additionally sensitivity was common among fixed partial dentures.

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