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

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## DECLARATION OF ORIGINALITY

I, Dr Laura Edalia, declare that this thesis titled: **"Evaluation of crowns and conventional fixed partial dentures provided to patients at the School of Dental Sciences, University of Nairobi"** is my original work and has not been submitted elsewhere for examination or award of a degree.

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## DEDICATION

This work is dedicated to my son Leon Mwaki and my husband and colleague Dr Mwirigi Kaaria who have been a constant source of motivation and encouragement.

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# TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## ACRONYMS

| | |
|---|---|
| CDA | California Dental Association |
| FDP | Fixed dental prostheses |
| FPD | Fixed partial dentures |
| PAL | Periodontal attachment loss |
| PDL | Periodontal ligament |
| PPD | Periodontal probing depth |
| RPD | Removable partial dentures |
| SC | Single crown |
| SDS | School of Dental Sciences |
| SPSS | Statistical Package for Social Sciences |
| UON | University of Nairobi |
| USPHS | United States Public Health System |

## DEFINITION OF TERMS

**Complications**: In this study, a complication is defined as a secondary disease or condition developing in the crown or fixed partial denture e.g. caries, need for endodontic treatment, loss of retention. Although some complications resulted in failure, not all prostheses with complications were deemed to have failed.

**Failure**: Loss of prostheses or prostheses in need of replacement.

**Success**: Prostheses where restored teeth remain intact, fixed prosthesis remains intact, restored tooth remains free from radiographic and clinical signs and symptoms of pulp deterioration. Crowns and prostheses in need of correction which did not necessitate replacement were deemed to be successful.

**Length of service**- the lifetime of FPDs and crown units from cementation up to the time of examination or failure.

**Span of fixed partial denture-** this was used to refer to the total number of units present on a fixed partial denture, it included the total number of retainers and pontics present on the prostheses.

**Bone loss**- this was defined as when the distance between the cemento-enamel junction and the alveolar bone crest was greater than 2mm.

**Decementation** – loss of retention resulting in detachment of a crown or fixed partial denture from the supporting tooth/teeth where there is no underlying fracture of the teeth.

## ABSTRACT

**Background:** Fixed partial dentures (FPDs) have a high survival rate, however they are often associated with biological and technical complications. Patients treated with crowns and FPDs at the School of Dental Sciences (SDS) are usually not followed up due to lack of a proper recall system. Consequently, there are no available data on the outcomes of crowns and FPDs that have been provided to patients at the School of Dental Sciences.

**Objective:** To evaluate crowns and conventional fixed partial dentures provided to patients between the years 2009 and 2015 at the School of Dental Sciences, University of Nairobi.

**Study design**: This was a descriptive cross sectional study. The study sample comprised of patients who had received crowns and fixed partial dentures at the School of Dental Sciences between the year 2009 and 2015.

**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.

**Data analysis and presentation:** The data collected was analyzed using the Statistical Package for Social Sciences (SPSS v. 21, IBM). The information obtained was organized and

presented as descriptive statistics in form of tables and figures. Pearson's Chi square and Fisher's exact test were applied to test the relationship between various variables.

**Results:** Ninety seven patients were included in the study. Their ages ranged between 23 to 76 years, with a mean of 44.65 ( $\pm$ 12.61 SD) years. Thirty five (36.1%) of these were male and 62 (63.9%) were female. The patients evaluated had been provided with a total of 69 FPDs and 81 crowns. The mean length of service for the FPDs was 42.79 ($\pm$ 22.25 SD) months while it was 35.94($\pm$ 20.05 SD) months for the crowns.

Sensitivity to thermal stimuli, porcelain fractures and defective margins were the most common complications associated with FPDs. The success rate for FPDs was 75.3%. There was a statistically significant association between FPD design and success (Fisher's Exact Test = 8.194, p=0.018). Cantilever design demonstrated the lowest success rate. There was also a significant association between the position of the fixed partial denture in the mouth and success ($\chi^2$= 6.596, p = 0.017). Success rate was higher among FPDs located in the posterior region.

Decementation, sensitivity to thermal stimuli and defective margins were the most common complications associated with crowns. The success rate of crowns was 66.7%. There was statistically significant association between the level of training of the clinician and the success of crowns ($\chi^2$ = 7.772, p= 0.009). Crowns fabricated by graduate students had a higher success rate compared to those by undergraduate students and dental interns. There was also a statistically significant association 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.

**Conclusion:** 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 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.

# CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

## 1.1 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 ceramic.[1] 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.[1] 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 2010.[2] 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.[3] 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 modalities. Several complications may arise related to crown and fixed partial denture work.[4]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 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. 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 seven years at the School of Dental Sciences, with the aim of establishing their success rate, associated complications and factors that could have influenced their success.

## 1.2 Literature review

The search for literature was conducted electronically on PubMed and Medline data bases for suitable articles published in English. The keywords searched were "success OR complications OR outcomes OR survival," and "crowns OR fixed partial dentures OR bridges," indicated in the title. Additionally, a manual search was conducted using reference lists and articles retrieved from the electronic search and peer-reviewed journals. The articles were critically analysed and those that were deemed relevant were included in the literature review. Majority of these studies measured survival and failure with only few studies recording data on success; hence most of the studies included in the literature review relating to reported outcomes of crowns and fixed partial dentures were those that reported on survival and failure.

### 1.2.1 Reasons for crown placement

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 retention.[5]

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 unaesthetic. 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 brittle.[5] 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. Friedlander et al,[6] 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 others.[7] 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 premolars.[7]

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 morphology. 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.[8]

### 1.2.2 Survival of crowns

A systematic analysis of various outcome studies evaluating fixed tooth restorations highlighted varying descriptions of survival and success from various studies.[4] Fradeani & Redemagni described survival of crowns as the period between cementation and the time which the crown was shown to have failed irreparably.[9] In another study, it was simply described as "Crown not removed".[10]

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.[11]Another definition of success from a different study was the presence of restorations still in clinical service.[12]

Pjetturson et al,[13] 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 needs.[14]

The survival rates reported by Pjetturson et al,[13] 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%.[15]

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,[16,17,18] this has been attributed to compromised structural integrity due to caries, endodontic procedures, trauma, and preparation procedures for restorations.[19,20,21]Many times

restoration of these teeth involves use of intracanal posts to augment retention of the core prior to crowning.

In a retrospective analysis of failed restorations that were post retained, a mean survival time of 11 years was established.[22] A high initial failure rate was recorded, whereby 61% of the restorations were found to have failed during the first ten years. Several post related factors have been shown to exert influence on post retention and protection of tooth structure. These factors include the diameter, length, shape, surface design, and stiffness of the post as well as the type of luting cement used.[23] The remaining tooth structure and the presence of ferrule are key factors that influence fracture resistance. Superior fracture resistance is demonstrated in teeth that allow preparation of 1.5- 2mm ferrule.[24,25]

### 1.2.3 Failure and complications associated with crowns

Failure has been defined as defects in design or execution which necessitate the remaking of a prosthesis[22,26] or that lead to crown or tooth loss.[27] Whereas a complication may be defined as a secondary disease or condition developing in the course of a primary disease or condition.[28] In fixed prosthodontics, complications may be an indicator of clinical failure though this is not always the case as some complications can be managed without resulting in loss of the prostheses. Although complications may reflect substandard care, it is well recognized that they may occur even in situations where treatment procedures have been performed appropriately. [29]

Schwartz et al,[30] conducted a study whereby they evaluated crowns and FPDs that were deemed unserviceable. In this study 50.9% of the failures were attributed to oral disease and 43.6% to mechanical problems, whereas a similar survey conducted several years later reported failures due to oral disease at 28.5% in comparison to 69.5 % due to mechanical problems.[31] This difference was attributed to overall decline in caries incidence in the

population being studied and increased use of ceramo-metallic restorations with the attendant mechanical risks.

Miyamoto et al,[32] evaluated the outcomes of various treatment modalities over a period of 15 years. In evaluation of both restored and unrestored teeth, crowned teeth demonstrated a higher failure rate when compared with unrestored teeth. However the crowned teeth had fewer failures when compared with teeth with multisurface restorations that were not crowned.

Many root treated teeth in need of crowns will require intracanal posts.[8] A higher failure rate for post retained restorations in the maxilla has been reported as compared to post retained restorations in the mandible.[33] Within the maxilla those in the anterior region have been shown to have a higher failure rate as compared to those in the posterior region, this has been attributed to higher functional horizontal forces acting on the anterior teeth.[33,34,35]

In an evaluation of 260 post retained restorations that had failed, Petzfeldt et al found that tooth fracture was the most common cause of failure accounting for 51% of the failures. Post loosening and post fracture were the other common causes of failure accounting for 30% and 17% of the failures respectively.[23]

Complications associated with crowns may be broadly classified into biological, mechanical or esthetic complications. Biological complications that have been documented in studies include pain, secondary caries, periapical pathology, periodontal disease and effect on opposing teeth. Mechanical complications include fracture of the porcelain, tooth/root fracture, fractured prosthesis, loss of retention, defective margins, post loosening and post fracture.[4] Aesthetic complications on the other hand include recession, over contoured crowns, shade disharmony with adjacent teeth and chipping of porcelain with metal exposure.

These complications need intervention if the prostheses are to be salvaged. In some circumstances, replacement of the prostheses may be necessary.

A systematic review of studies on complications of fixed prosthodontic work reported mean complications prevalence of 11% for single crowns. The reported complications for single crowns and fixed partial dentures included conditions that resulted in need for endodontic treatment, caries, periodontal disease, porcelain fracture and loss of retention.[29]

In another study, crown fracture, aesthetics and secondary caries were the most common reasons for crown replacement accounting for 27%, 18% and 15% respectively. The crown fractures were more common in the porcelain jacket crowns (47%) than in the Porcelain Fused to Metal (PFM) crowns (19%).[7]

In an evaluation of post retained restorations, Petzfeldt et al[23]reported fracture of post, post loosening and fracture of teeth as some of the complications associated with these types of restorations. Fracture of the tooth was more commonly encountered with tapered posts as compared with parallel posts. Long serving restorations prior to failure demonstrated an increased risk of tooth fracture as compared to post loosening and post fracture. A higher incidence of post fracture was recorded among male patients as compared to female patients, this was attributed to increased masticatory forces among the males.[23]

### 1.2.4 Fixed partial dentures

Tooth supported FPDs represent one modality for replacement of missing teeth. The usual configuration for an FPD utilizes an abutment tooth on each end of the edentulous space to support the prosthesis. The component of the FPD which replaces the missing tooth is referred to as a pontic. FPDs can be expected to provide long term service if the abutment teeth are periodontally healthy, the edentulous span is short and the retainers are well designed.[5]

Rigid connectors between pontics and retainers are the preferred way of fabricating most fixed partial dentures. This is because this design can achieve desirable strength and stability while minimizing stress on the restoration. However in a long span prosthesis with a lone standing pier abutment, a non-rigid connector is usually recommended to act as a stress breaker minimizing the stress being transmitted to the abutments. [5]

Other variants of tooth supported fixed partial denture designs include resin bonded and cantilever FPDs. The resin bonded FPD is a conservative design that is utilized on defect free abutments in situations where a single tooth is missing. This prosthesis requires minimal preparation restricted to enamel. It is the preferred design in younger patients whose large pulps bear high endodontic risks with extensive abutment preparation.[5]

A cantilever FPD is one that has an abutment or abutments at one end only. It is usually recommended in the replacement of only one tooth. This design is potentially destructive hence its use is limited to well selected case where the benefits outweigh the risks and in the absence of more suitable alternatives. [5]

Need for FPDs is necessitated by missing teeth. Teeth may be missing as a result of congenital absence or due to loss which may occur as a result of varied reasons**.** Caries and periodontal disease have been cited as the main reasons for tooth loss. For people above 40 years of age, periodontal disease has been identified as the most common cause of tooth extraction. [3]

In a literature review on tooth loss in adults in Europe, the mean number of lost teeth was shown to increase with age. Many subjects aged 60 and above had reduced number of teeth and were categorized to be in need of prosthodontic treatment.[36]A study conducted in a population in Tanzania revealed a similar trend of increased tooth loss with age. The mean

number of teeth present in the 30-34 year olds was shown to be higher than in those ≥ 50 year old. In all age groups, molar teeth were the most commonly missing teeth. For all tooth types, dental caries was the predominant cause of loss apart from the mandibular incisors where periodontal disease was the most common cause for loss.[37]

### 1.2.5 Survival of fixed partial dentures

A systematic analysis of various outcome studies evaluating fixed tooth restorations highlighted varying descriptions of survival from various studies.[4]

Valderhaug et al, [38] described survival as the fixed prosthesis remaining intact, restored tooth remaining intact, free from clinical and radiographic signs and symptoms of pulp deterioration. Pjeturrson et al,[39] considered a fixed partial denture to have survived if it remained in situ with or without modification over the observation period.

The authors of the systematic analysis,[4] noted that these variations in definitions did not facilitate direct comparisons of fixed prosthodontic outcomes. Nevertheless, these studies provided useful information regarding expected survival of fixed prostheses and associated factors that influence their survival.

Several factors which are believed to influence the success and survival of FPDs have been investigated. These include the prosthesis design, the span of prosthesis, use of root treated abutments, presence of posts and cores on abutments, choice and number of abutments.

Chai J et al, [40] demonstrated the effect of prosthesis design on survival of fixed partial dentures. Three-unit conventional FPDs with full-veneer retainers had the highest survival rate (82%) whereas 3-unit resin-bonded FPDs had the lowest survival rate(63%).The cumulative survival rate of 2-unit cantilevered resin-bonded FPDs at 48 months was

surprisingly high at 81%, this was attributed to the fact that this design was avoided in the replacement of molars.

A different study evaluating the relationship between design and failure showed that the number of retainers rather than the number of units present in a prosthesis had an influence on the duration of service of the bridgework.[41] Bridges with only one or two retainers had a higher mean lifespan ( >7 years) when compared to those with three or more retainers (4 years). In the same study, posterior bridges had a higher mean life span (7.6years) as compared to anterior bridges (5 years), this was attributed partly to the aesthetic importance of anterior bridges whereby even a small porcelain fracture or marginal fault would be very displeasing to the patient and warrant replacement as opposed to bridges in the posterior segment which are considered to be in the non-aesthetic zone.[41]

In evaluation of effect of design on survival, Leempoel et al, revealed lower survival rates among bridges that did not conform to ante's law.[16] Ante's law states that the root surface area of the abutment teeth has to equal or surpass that of the teeth being replaced with pontics.[42] Loss of FPDs over 4–5 years in one study was shown to occur at a similar rate with either hybrid, implant or tooth supported reconstructions.[43] However a different study reported higher survival rates for tooth supported FPDs and implant supported FPDs when compared to hybrid FPDs thereby recommending that combined tooth-implant supported FPDs should not be chosen as a first option for treatment.[39]

Teeth that serve as FPD abutments bear greater stresses in function than single crown abutments. Consequently, the prognosis of root treated teeth as abutments in fixed partial dentures has been called into question. One study reported that use of root canal treated teeth as abutments impacted negatively on the survival rate of prostheses[16]. Hochman et al,[44] also reported higher failure rates in single unit crowns and crown units in bridges in non vital teeth as compared to the vital ones.

Several authors propose that pulpless teeth for use as abutments require reinforcement against fracture which may be achieved by placement of a dowel.[45,46,47] On the other hand there is conflicting evidence which suggests that dowel placement does not result in improved clinical success rate of endodontically treated teeth used as abutments.[21]

Nyman and Lindhe,[48] evaluated 299 individuals with 332 FPDs for a period of 5 to 8 years. In their study, 75% of the abutment teeth that fractured were endodontically treated, restored with posts and were serving as terminal abutments. Similarly another study,[44] reported a significantly higher mean life span of fixed partial dentures in a group of teeth without posts and cores. On the contrary another study[16] reported no significant difference in survival between bridges with or without post and core build up.

### 1.2.6 Failures and complications associated with fixed partial dentures

Failure has been defined as defects in design or execution which necessitate the remaking of a prosthesis[22, 26]or that lead to crown or tooth loss.[27]

Several studies have identified caries of the abutment teeth as the main cause of failure of FPDs.[17,31,44,49] In one of the studies which evaluated 89 FPDs, 13 (15%) were identified as unsatisfactory or were replaced because of failure, dental caries accounted for 38% of the failures.[49] In another study dental caries accounted for 22% of failures.[31] The mean length of service in these studies was 16 and 11 years respectively. In other studies, need for endodontic treatment for the abutment teeth represented the major cause of the failures.[40,50] Pjetursson et al reported similar findings , they cited caries and loss of pulp vitality as the most frequent causes of failure of conventional tooth supported FPDs.[39]

A comparative evaluation of complications and failures with FPD on implants and those on teeth revealed favourable clinical conditions for both tooth and implant abutments after 4–5

years of function. However, significantly more porcelain fractures were found in FPDs on implants. This study also associated bruxism with more failures unlike impaired general health which had no significant influence.[43]

Numerous studies evaluating fixed partial dentures have been conducted in dental schools and teaching hospitals.[44,50,51] Cheung et al,[50] conducted a clinical evaluation of bridges at a teaching hospital. In this seven year retrospective study, 35 bridges (20.7%) failed and had to be replaced. The most frequent cause of failure was endodontic, followed by loss of retention, then persistent pain and sensitivity. Failures of endodontic origin affected mostly the anterior teeth. This was attributed to the large pulp size of these teeth and the amount of tooth reduction required for ceramometal retainers as all the bridges that failed in the study had this kind of retainers. 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 consisted of bridges which had been lost or had to be reconstructed due to failure.[51] Insufficient retention, caries, and esthetics were the commonest reasons for failures. Esthetic reasons included wear, discoloration of the acrylic facing, and recession of the gingiva. 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.[44] Caries was found to be the most frequent cause of failure. Non-vital abutments and restoration with post and cores contributed significantly to the failures.

Sorensen and Martinoff,[52] evaluated 1273 endodontically treated teeth. The teeth were grouped into various categories which included those with no crowns, single teeth, those with single crowns, fixed partial denture abutments and removable partial denture abutments. The greatest failure rate (24.2%) was associated with pulpless teeth without a crown. The failure

rate of RPDs (22.6%) was higher than that of FPDs (10.2%) and that of teeth with crowns (5.2%). In single teeth with coronal coverage, the presence of intracanal reinforcement resulted in a decreased success rate however the presence of intracanal reinforcement had limited effect on the success rate of FPD abutments. The percentage of tooth fractures was higher in the RPD abutments followed by FPD abutments and was lowest in the single crowns.[52]

A systematic review of studies on complications of fixed prosthodontic work reported mean complications prevalence of 27% and 26% for fixed partial dentures and resin bonded bridges respectively. [29] The reported complications for fixed partial dentures included conditions that resulted in need for endodontic treatment, porcelain fracture, loss of retention, periodontal disease, caries, esthetics, tooth fracture and prosthesis fracture. Resin bonded bridges associated complications included debonding, tooth discoloration and porcelain fracture while post and cores were mainly affected by post loosening, root fracture, caries and periodontal disease.[29]

### 1.2.7 Clinical systems for evaluation of fixed prosthodontic treatment

A systematic review of different studies reporting on fixed prosthodontic treatment outcomes revealed that definitions of success and survival varied greatly, so did the criteria used to evaluate the data.[4] These variations in definitions do not facilitate the interpretation and reliable combination of data from several studies. As a result, this may hinder any meaningful direct comparisons of outcomes of fixed prosthodontic treatment.

In an attempt to standardize the measurement of outcomes in assessment of longevity of restorations, several recommendations on reporting for such studies have been made.[53] Two clinical systems for evaluating dental restorations are recommended; the Ryge criteria and the

California Dental Association (CDA) criteria. The Ryge criteria was developed by Cvar and Ryge in 1971 for use by the United States Public Health Service in clinical evaluation of dental restorative materials and is also termed as the USPHS criteria.[54] The CDA criteria is a variation of the USPHS system used by the California Dental Association (CDA) titled "Standards of quality of dental care".[55] Both systems evaluate colour, surface characteristics, anatomic form and marginal characteristics. Both are based on an ordinal scale and involve categorization of dental restorations or prostheses as either 'acceptable' or not 'acceptable'.

## 1.3 Problem Statement

Despite high survival rate of Fixed Partial Dentures, biological and technical complications are frequent.[39,40,43] These complications may result in loss of the prostheses or impairment of function. These functions may include aesthetic, masticatory and social functions. As a result quality of life of the individual may be affected. Follow up of every patient who receives crowns and fixed partial dentures therefore becomes necessary. However many patients treated at the School of Dental Sciences, University of Nairobi are not followed up due to lack of a proper recall system. Occurrence of the above mentioned complications is therefore unknown, thus may remain unresolved leading to patient dissatisfaction, suboptimal service from the prostheses and even loss of the prostheses. Failed prostheses may also serve as a risk factor for other oral diseases.

Currently there is minimal available data on outcomes of crowns and fixed partial dentures that have been provided to patients at the School of Dental Sciences. Hence there is scanty information on the success, failure, survival rate or complications pertaining to these prostheses.

## 1.4 Justification of the study

An evaluation of the different outcomes of crowns and fixed partial dentures fabricated at the School of Dental Sciences, University of Nairobi will provide scientific evidence that will inform treatment planning and patient education for decision making in future.

The study will serve as an audit of the clinical work done at the Dental School giving an insight as to the success, survival, failure rate and complications of crowns and fixed partial dentures. Knowledge of these outcomes will provide insight on the various stages of treatment that need to be improved, be it the treatment planning stage, tooth preparation stage or technical/ laboratory stage in order to minimize occurrence of failures and complications.

Patients with complications and failed prostheses will be managed appropriately therefore ensuring they receive optimal service from their prostheses. In some cases, management of complications will prevent occurrence of more catastrophic failures.

## 1.5 Objectives

### 1.5.1 Broad objective

To evaluate crowns and conventional fixed partial dentures provided to patients at the School of Dental Sciences, University of Nairobi.

### 1.5.2 Specific objectives

i. To determine success rate of crowns and conventional fixed partial dentures provided to patients at the School of Dental Sciences.

ii. To determine factors associated with success of crowns and conventional fixed partial dentures provided to patients at the School of Dental Sciences.

iii. To determine complications associated with crowns and conventional fixed partial dentures provided to patients at the School of Dental Sciences

## 1.6 Variables

**Table 1.1 Study variables**

| Variable | Measurement |
|---|---|
| **Sociodemographic variables** | |
| Age | Years as at last birthday |
| Gender | Male or female |
| Occupation | Employed, unemployed, self employed |
| Level of education | Primary, secondary, tertiary |
| **Independent variables** | |
| Age of crown/FPD | Months |
| Span of FPD | Number of units |
| Design of FPD | Fixed-fixed, fixed-movable, cantilever, resin bonded |
| Root canal status of abutment/crowned tooth | Presence/ absence of root filling |
| Presence of post | Presence or absence of post |
| Level of training | Undergraduate, Graduate, Intern |
| Position of crown/FPD | Anterior/posterior |
| Brushing frequency | Number of times per day |
| Visits to the dentist | Number of times per year |
| Systemic illness | Nature of systemic illness |
| Patient satisfaction | Satisfied/ Dissatisfied |

| **Dependent variables** | |
|---|---|
| Success | Excellent, acceptable |
| Failure | Need for replacement, missing |

## 1.7 Null hypothesis

1. There will be no association between the span of prostheses and success of fixed partial dentures provided to patients at the School of Dental Sciences.
2. There will be no association between the clinician's level of expertise and the success of crowns and fixed partial dentures provided to patients at the School of Dental Sciences.
3. There will be no association between the vitality status of crowned and abutment teeth and the success of crowns and fixed partial dentures provided to patients at the School of Dental Sciences.

# CHAPTER 2: MATERIALS AND METHODS

## 2.1 Study Design

This was a descriptive cross sectional study.

## 2.2 Study Area

The study was conducted at the School of Dental Sciences, University of Nairobi. The School is situated off Argwings Kodhek road, in Upper Hill area of Nairobi. It offers undergraduate, postgraduate and doctoral programs in dentistry. Patients are treated by both the undergraduate and graduate students under supervision. The school is also a dental internship training centre for newly qualified dentists. These interns also attend to patients with guidance and supervision from tutors.

## 2.3 Study Population

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. This was influenced by availability of records for crowns and fixed partial dentures provided to patients, records for work done earlier than 2009 could not be traced. Data collection commenced at the beginning of 2016.

## 2.4 Sample size determination

Sample size determination was calculated using Fisher's method of sample size determination.[56] Based on a study evaluating the complications of fixed prosthodontics the prevalence of complications associated with fixed partial dentures was 27%.[29]

Hence using the formula:-

$N= z^2pq/ d^2$

Where,

N= desired sample size when population is greater than 10,000

z= standard normal deviate, usually set at 1.96 at the 95% confidence level

p= prevalence

q= 1-p

d= degree of accuracy set at 0.05

Therefore,

$N= (1.96)^2 (0.27) (0.73)/(0.05)^2$

= 303

Records from the UON dental school clinic show the total number of patients provided with single crowns and fixed partial dentures between 2009 and 2015 to be 208. For population less than 10000 the following formula is used:

nf = N/ 1+ (N/n)

Where,

nf= desired sample size when the population is less than 10,000

N= the desired sample size when the population is greater than 10,000

n= estimate of the population size

Hence;

nf = 303/ (1+ 303/208)

= 123

## 2.5 Sampling method

Purposive sampling method was utilized. Patients who had been provided with crowns and FPDs at the School of Dental Sciences, University of Nairobi 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.

## 2.6 Inclusion criteria

- Patients provided with crowns and tooth supported fixed partial dentures at the School of Dental Sciences between 2009 and 2015.
- Patients who consented to the study.

## 2.7 Exclusion criteria

- Patients with crowns and fixed dental prostheses provided outside the time frame of the study.
- Patients whose treatment records were missing.
- Patients who failed to consent to the study.
- Patients with prostheses provided outside the School of Dental Sciences.
- Patients not eligible for radiographic evaluation.

## 2.8 Data collection instruments and techniques

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. A total of 208 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 nine of these patients could not be reached as their numbers were out of service or had changed ownership. Out of 179 patients who were contacted and invited for a review appointment, 97 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 which was available in English and Swahili (Appendix I & II). 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 also availed in the two languages (Appendix III & IV). 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 (Appendix V). This questionnaire was administered by the principal investigator.

*Clinical examination*

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 at the School's Central Sterile Services Department.

The following details were recorded in the data collection form (Appendix VI) 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 (Appendix VII) 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 using Nikon camera D3200. 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*

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).

*Information from patient records*

Information regarding length of service, level of training of clinician, materials used for fabrication, type of post used and type of cement used for luting was gathered from patient files. This information was also captured in the data collection form (Appendix VI).

For the purpose of this study a crown or fixed partial denture was deemed to be a failure if:

(i) There was fracture of the retainer, pontic, or abutment.

(ii) Caries was present in the abutment /crowned tooth.

(iii)The crown or fixed partial denture had to be remade.

(iv)The crowned tooth or one of the abutment teeth had been lost.

(v)The crown or fixed partial denture was missing at the time of examination

## 2.9 Data validity and reliability

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.

## 2.10 Data analysis and presentation

The data collected was analyzed using the statistical package for social sciences (SPSS v.21, IBM) for Windows and Microsoft excel. The data was presented in form of graphs and tables.

Chi square test and Fisher's exact test were performed to identify associations between the independent and dependent variables. The p-value for statistical significance was set at less than 0.05.

## 2.11 Ethical consideration

Ethical approval to conduct the study was obtained from the Kenyatta National Hospital and University of Nairobi Ethics, Research and Standards Committee. The purpose of the study and expected benefits was clearly explained to the participants and informed consent was obtained from them. Information obtained was kept confidential.

Participation was voluntary and participants were at liberty to terminate participation without victimization or denial of treatment. Patients with associated complications from existing prostheses were offered treatment within the school or referred accordingly to a qualified specialist for management.

# CHAPTER 3: RESULTS

## 3.1 Sociodemograhic characteristics

A total of 97 patients were examined. These patients had been provided with a total of 150 prostheses (81 crowns, 69 FPDs). The age of the patients ranged from 23 to 76 years, averaging (44.65± 12.61) years (Figure 3.1). Thirty five (36.1%) were male and 62 (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 four (76.3%) participants had tertiary level of education while 18(18.6%) and 5(5.1%) had secondary and primary level of education respectively. Fifty four (55.7%) of them were employed while 34 (35.1%) were self-employed and 9(9.2%) were unemployed.

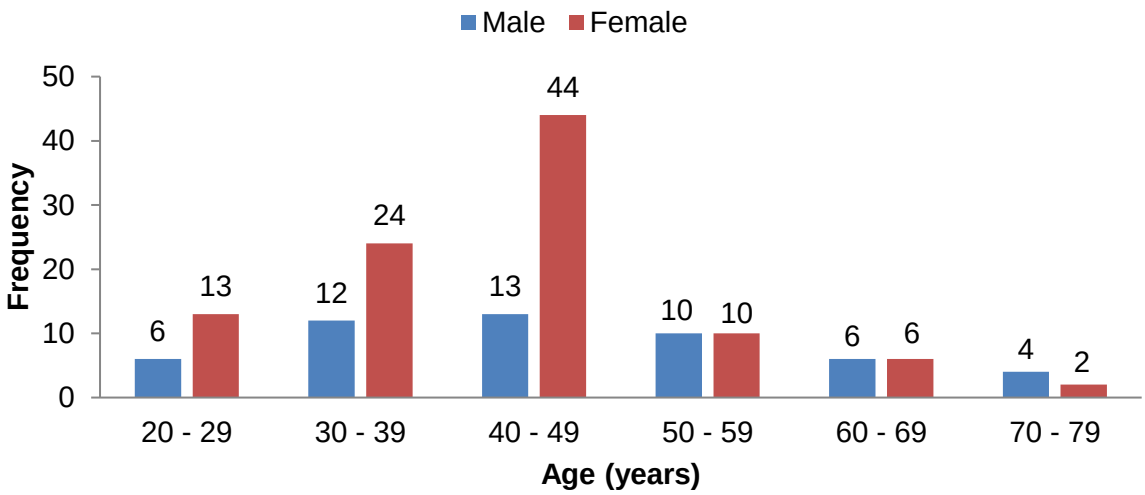


**Figure 3.1: Age and gender distribution**

## 3.2 Oral hygiene habits and oral health seeking behaviour

Seventy two (74.3 %) participants reported that they brushed their teeth twice a day, while 23 (23.7%) brushed once a day (Table 3.1). A total of 57(58.8%) reported use of dental floss for interdental cleaning while only 9 (9.3%) reported use of superfloss (Table 3.2). The mean plaque score was 1.4($\pm$0.5 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 3.3]. A Spearman's rank-order correlation coefficient showed a non-statistically significant association between frequency of brushing and plaque score [$r_s(95) = 0.071$, $p = 0.495$].

**Table 3.1 Brushing frequency**

| **Brushing frequency** | **n (%)** |
|---|---|
| Once a day | 23 (23.7) |
| Twice a day | 72 (74.3) |
| More than twice a day | 1 (1.0) |
| Other | 1 (1.0) |

**Table 3.2 Interdental hygiene aids**

| **Oral hygiene aids** | **Yes** | **No** |
|---|---|---|
| Regular dental floss | 57(58.8%) | 40(41.2%) |
| Superfloss | 9 (9.3%) | 88(90.7%) |

**Table 3.3 Association between level of education and brushing frequency**

| | Frequency of brushing | |
|---|---|---|
| **Characteristics** | **Once a day** | **Twice a day** |
| **Education level** | | |
| Primary school | 1(1%) | 4(4.1%) |
| Secondary school | 2(2%) | 15(15.5%) |
| Tertiary level | 20(20.6%) | 53(54.6%) |
| | Fisher's Exact Test(2) = 1.748, p = 0.401 | |

Eighty seven (89.7%) of the participants visited the dentist on need basis only, while 7(7.2%) visited annually, 2 (2.1%) once in three months and 1(1%) biannually.

## 3.3 Chronic illnesses

Seventy one (73.2%) participants did not have any underlying medical condition. The most common chronic illness among the participants was hypertension affecting 19(19.6%) participants (Table 3.4).

**Table 3.4 Chronic illnesses**

| **Chronic illnesses** | **n (%)** |
|---|---|
| Diabetes mellitus | 3 (3.1%) |
| Hypertension | 19 (19.6%) |
| Other | 4 (4.1%) |
| None | 71 (73.2%) |

## 3.4 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 3.5).

**Table 3.5 Distribution of crowns and fixed partial dentures**

| 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 dental interns. They provided a total of 54(66.7%) crowns and 55(79.7%) FPDs (Table 3.6).

**3.6 Level of training of clinicians who provided prostheses**

| 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 |

The mean length of service for crowns was (35.94 $\pm$ 20.05) months, the shortest length of service was 8 months whereas the longest was 80 months (Figure 3.2). For the FPDs, the mean length of service was (42.79 $\pm$ 22.25) months, the shortest length of service was 6 months whereas the longest was 84 months (Figure 3.3). This was calculated only for

restorations that were present at the time of examination (68 crowns, 66 FPDs) because length of service for missing restorations could not be accurately determined.

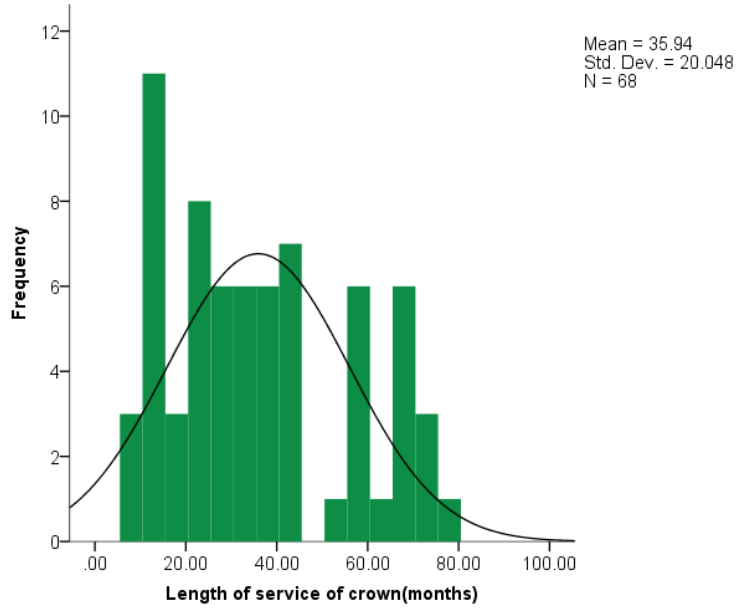


**Fig 3.2 Length of service of crowns**

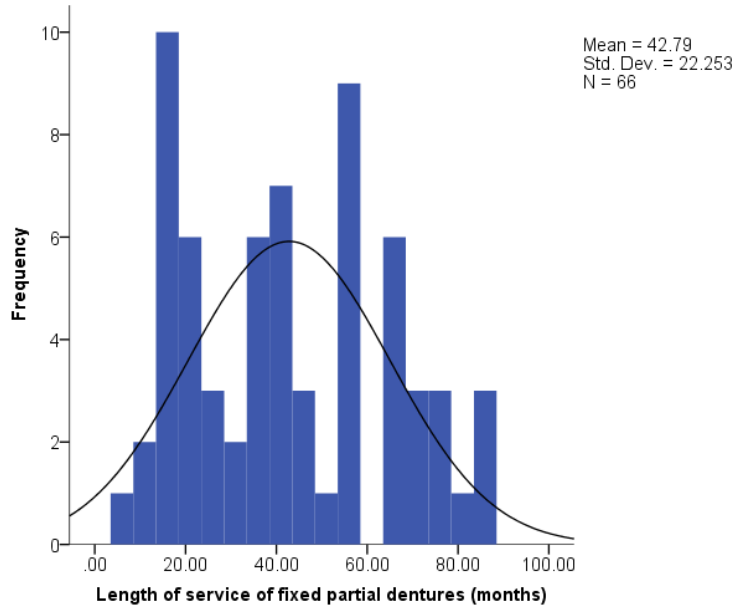


**Figure 3.3 Length of service of fixed partial dentures**

## 3.5 Fixed Partial Dentures

### 3.5.1 Fixed partial denture designs

Fifty nine (85.5%) fixed partial dentures were of the fixed-fixed design, while 7(10.1%) 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.

Most of the FPDs evaluated were three unit and four unit accounting for 40(58%) and 18(26.1%) FPDs respectively. The 6-unit and 7 unit FPDs were the least, accounting for 2 (2.9%) FPDs each (Fig 3.4). The total number of units was 241, of these 143 were abutments and 98 were pontics.

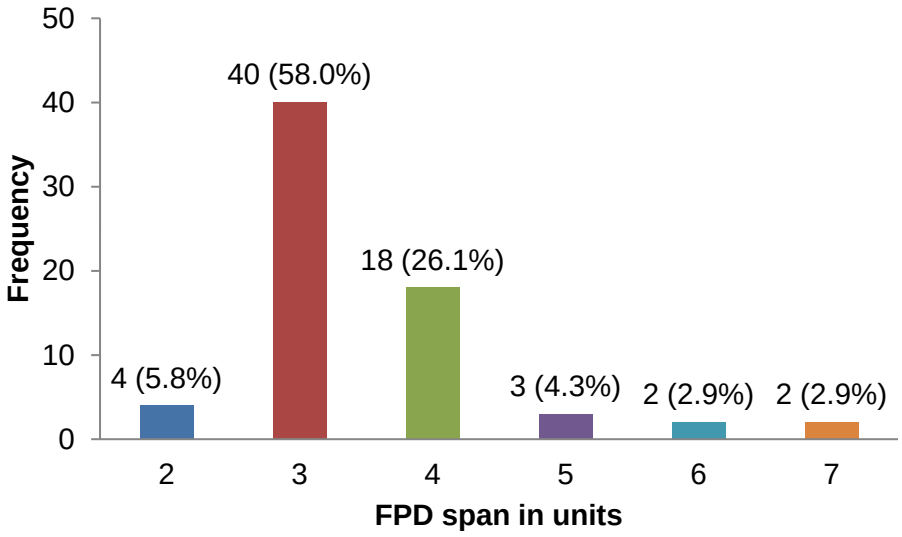


**Figure 3.4: Fixed partial denture span distribution**

### 3.5.2 Materials used to fabricate fixed partial dentures

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.

Forty(58%) of the FPDs had been cemented by use of zinc phosphate cement, whereas calcium hydroxide and zinc polycarboxylate cements accounted for the least having been used to cement 1 (1.5%) FPD each (Table 3.7).

**Table 3.7 Luting cements for fixed partial dentures**

| Type of cement | n (%) |
|---|---|
| Zinc phosphate | 40 (58%) |
| Resin cement | 7(10.1%) |
| Glass ionomer cement | 3(4.3%) |
| Calcium hydroxide | 1(1.5%) |
| Zinc polycarboxylate | 1 (1.5%) |
| Not recorded | 17(24.6%) |

### 3.5.3 Clinical evaluation of fixed partial dentures

The CDA criteria was used to evaluate the quality of fixed partial dentures. A total of 69 FPDs had been given to patients within the study period. At the time of evaluation, one had been replaced and two were missing, thus a total of 66 FPDs were assessed. These had a total of 231 units (137 abutments, 94 pontics).

In evaluation of colour and surface characteristics, 61(92.4%) FPDs were found to be acceptable. The anatomic form of 63(95.4%) FPDs was acceptable whereas the marginal integrity was acceptable in 54(81.8%) FPDs. Some of the prostheses were unacceptable due to multiple reasons. In total 52 FPDs (78.8%) were deemed acceptable while 14(21.2%) were deemed unacceptable (Table 3.8).

**Table 3.8 Evaluation of fixed partial dentures using CDA criteria**

| Characteristic | Range of excellence n (%) | Range of acceptability n (%) | Correct for prevention n (%) | Replace statim n (%) | Total |
|---|---|---|---|---|---|
| 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 |

### 3.5.4 Periodontal evaluation of fixed partial denture abutments

The periodontal health evaluation was done for all 137 abutments. This entailed the evaluation of the gingival score, periodontal probing depth, periodontal attachment loss and mobility for each of the abutments. Seventy five (54.8%) of the abutment teeth had signs of moderate gingivitis while 27(19.7%) had no signs of gingivitis (Table 3.9).

**Table 3.9 Gingival score for FPD abutments**

| Gingival Score | n (%) |
|---|---|
| Healthy | 27(19.7%) |
| Mild gingivitis | 31(22.6%) |
| Moderate gingivitis | 75(54.8%) |
| Severe gingivitis | 4(2.9%) |

Majority of the teeth [136(99.3%)] had probing depths ranging between 1 and 3. Only 1 (0.7%) tooth had a probing depth greater than 3 (Table 3.10).

**3.10 Periodontal probing depth for FPD abutments**

| PPD (mm) | n (%) |
|---|---|
| 1 | 21(15.3%) |
| 1.5 | 1(0.7%) |
| 2 | 70(51.1%) |
| 3 | 44(32.2%) |
| 4 | 0 |
| 5 | 0 |
| 6 | 1 (0.7%) |

Thirty seven teeth (27%) exhibited evidence of periodontal attachment loss (Table 3.11). Three abutments (2.2%) exhibited grade I mobility whereas the remaining 134 teeth (97.8%) were not mobile.

**Table 3.11 Periodontal attachment loss for FPD abutments**

| PAL(mm) | n (%) |
|---|---|
| 0 | 100 (73%) |
| 1-2 | 9 (6.6%) |
| 3-4 | 26 (19%) |
| >5 | 2(1.4%) |

### 3.5.5 Radiographic evaluation of fixed partial denture abutments

Three FPDs had been lost or replaced by the time of evaluation; these had been supported by a total of six abutments. Hence a total number of 137 abutment teeth were evaluated radiographically for presence of dental caries, periapical radiolucency, root fillings, posts, bone loss and widening of periodontal ligament space.

Two (1.4%) of the FPD abutments exhibited evidence of radiolucency consistent with caries 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.

Abutments that were endodontically treated accounted for 40(29.2%) of the total number of abutments. Sixteen (40%) of the endodontically treated abutments had been restored with posts. Twelve (75%), of the posts utilized were fibre posts while 2(12.5%) were prefabricated metallic posts. In two (12.5%) of the cases the type of post utilized was not indicated in the patient notes. All the fibre posts were smooth and tapered, one of the metallic posts was threaded and tapered whereas one metallic post was threaded and parallel.

Eleven abutments (8%) exhibited widening of PDL space; three of these (27.2%) were endodontically treated. (Table 3.12).

**Table 3.12 Radiographic evaluation of FPD abutments**

| | Yes | No | Total |
|---|---|---|---|
| Radiolucency indicative of caries | 2(1.4%) | 135(98.6%) | 137 |
| Periapical radiolucency | 6(4.4%) | 131(95.6%) | 137 |
| Root treated | 40(29.2%) | 97(70.8%) | 137 |
| Presence of post | 16(11.7%) | 121(88.3%) | 137 |
| Widening of PDL space | 11(8%) | 126(92%) | 137 |

### 3.5.6 Success rate of fixed partial dentures

A total of 69 FPD's had been provided to patients within the study period. Fifty two (75.4%) were considered successful, 14(20.3%) were indicated for replacement due to various reasons while 3(4.3%) were missing at the time of evaluation. The success rate was 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.

For the three FPDs which were missing, one had been documented in the patient's file as having been replaced due to defective margins. As for the other two, the causes of failure were reported by the patients as one due to fracture and the other due to loss of retention.

There was a statistically significant association 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 ($X^2$= 6.596, p= 0.017). Posterior FPDs had a higher success rate when compared to the anterior ones (Table 3.13).

Associations between length of service, root treated abutments, span of prostheses and success of FPDs were tested by use of Fisher's exact test whereas association between the presence of posts, level of clinician's training and success of FPDs was tested by use of Chi Square test. No statistically significant association was elicited (Table 3.13).

**Table 3.13 Association between various variables and success of FPDs**

| | Success | |
|---|---|---|
| **Characteristics** | **Yes** | **No** |
| **Fixed Partial Denture Design** | | |
| Cantilever Bridge | 2 | 5 |
| Fixed-Fixed Bridge | 47 | 12 |
| Resin Bonded Bridge | 3 | 0 |
| | *Fisher's Exact Test(3) =8.194, p = 0.018 | |
| **Position of fixed partial denture** | | |
| Anterior | 13 | 10 |
| Posterior | 39 | 7 |
| | *$\chi^2$(1) =6.596, p = 0.017 | |
| **Length of service of Fixed Partial Denture (months)** | | |
| 0.5 – 24 | 16 | 6 |
| 25 – 48 | 15 | 5 |
| 49 and above | 21 | 6 |
| | Fisher's Exact Test(2) = 0.258, p = 0.939 | |
| **Presence of root filling in Fixed Partial Denture** | | |
| Yes | 14 | 8 |
| No | 38 | 9 |
| | Fisher's Exact Test(1) =2.300, p = 0.143 | |
| **Span of prosthesis** | | |
| 2nd Unit Bridge | 2 | 2 |
| 3rd Unit Bridge | 32 | 8 |
| 4th Unit Bridge | 13 | 5 |
| 5th Unit Bridge | 3 | 0 |
| 6th Unit Bridge | 0 | 2 |
| 7th Unit Bridge | 2 | 0 |
| | Fisher's Exact Test(5) = 7.651, p = 0.114 | |
| **Presence of post in Fixed Partial Denture** | | |
| Yes | 9 | 6 |
| No | 43 | 11 |
| | $\chi^2$(1) =2.436, p = 0.174 | |
| **Level of training (Fixed Partial Denture)** | | |
| Undergraduate level | 8 | 6 |
| Graduate | 44 | 11 |
| | $\chi^2$(1) =3.140, p = 0.092 | |

Chi-Square Test for Independence (Pearson Chi-Square) was used.
Fishers Exact Test was used.
*p<0.05

### 3.5.7 Complications associated with fixed partial dentures

Sensitivity, defective margins, porcelain fractures and loss of retention were the most common complications associated with FPDs affecting 18(26.1%), 13(18.8%), 6(8.7%), 6(8.7%) prostheses respectively (Figure 3.5). Photographs in Appendix XI depict some of the complications that were associated with FPDs (Figure I- IV).

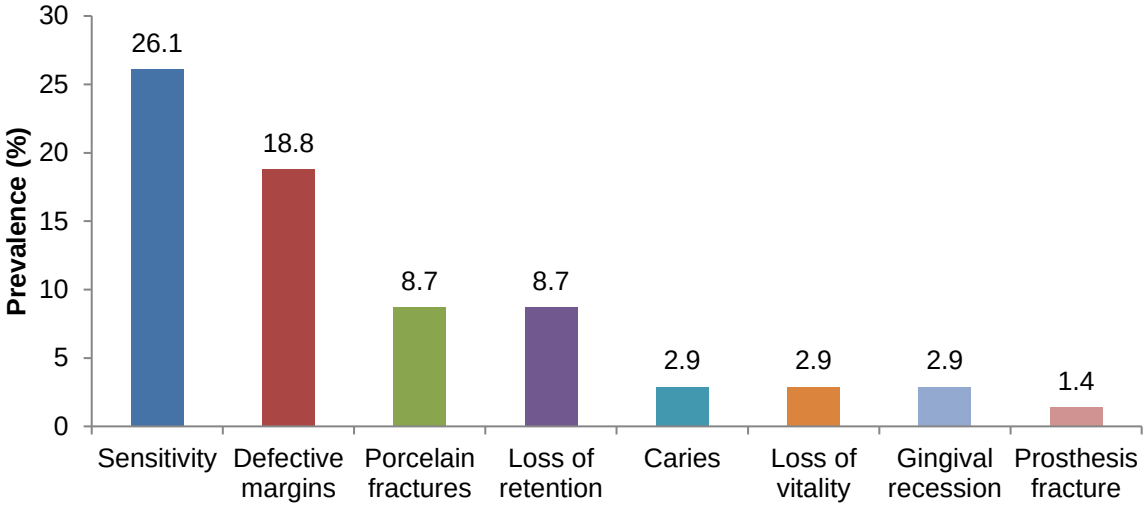


**Figure 3.5 Complications associated with fixed partial dentures**

### 3.5.8 Patient satisfaction with fixed partial dentures

This question was posed only to participants with existing prostheses, those whose prostheses had been lost or replaced were not included. For those with more than one prosthesis, they answered separately for each prosthesis. Most of the participants were content with their prostheses with 19 (28.8%) expressing they were very satisfied and 42 (63.6%) expressing that they were satisfied. Four of them (6.1%) expressed dissatisfaction with their prostheses while one participant (1.5%) was very dissatisfied (Table 3.14). There was a significant association between patient satisfaction and success (Fisher's exact test = 11.187, p= 0.006) Table 3.15.

**Table 3.14 Patient satisfaction with fixed partial dentures**

| Success | Very satisfied n (%) | Satisfied n (%) | Dissatisfied n (%) | Very dissatisfied n (%) | Total |
|---|---|---|---|---|---|
| Yes | 16(24.2%) | 35(53%) | 1(1.5%) | 0 | 52 |
| No | 3(4.5%) | 7(10.6%) | 3(4.5%) | 1(1.5%) | 14 |
| Total | 19(28.8%) | 42(63.6%) | 4(6%) | 1(1.5%) | 66 |

**Table 3.15 Association between patient satisfaction and success of FPDs**

| | Success | |
|---|---|---|
| **Characteristics** | **Yes** | **No** |
| Satisfaction rating for fixed partial dentures | | |
| Satisfied | 51(98.1%) | 10(71.4%) |
| Dissatisfied | 1(1.9%) | 4(28.6%) |
| | *Fisher's Exact Test(1) = 11.187, p = 0.006 | |

* $p < 0.05$

## 3.6 Crowns

### 3.6.1 Distribution of crowned teeth

Maxillary incisors were the most commonly crowned teeth accounting for 39 (48.1%) of the crowned teeth. Maxillary premolars and mandibular molars were also frequently crowned accounting for 17(21%) and 13(16%) of the crowned teeth respectively. No crowned mandibular canines were encountered in the study whereas maxillary canines and mandibular incisors were the least commonly crowned teeth accounting for 2(2.5%) crowns each (Table 3.25).

**Table 3.16 Distribution of crowned teeth**

| 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%) |

### 3.6.2 Materials used to fabricate crowns

A total of 81 crowns had been provided to patients participating in the study. 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.

Zinc phosphate cement was the most commonly used luting cement; it was used in 59 (72.8%) crowns. Glass ionomer cement, resin cement and calcium hydroxide were less commonly utilized. There was no record of the luting agent used for 14 (17.3%) crowns (Table 3.17).

**Table 3.17 Luting cements used for crowns**

| Cement type | n (%) |
|---|---|
| Zinc phosphate | 59(72.8%) |
| Glass Ionomer cement | 4(4.9%) |
| Resin cement | 3(3.7%) |
| Calcium hydroxide | 1(1.23%) |
| Not recorded | 14(17.3%) |

### 3.6.3 Clinical evaluation of crowns

Thirteen (14.6%) crowns were either missing or had been replaced at the time of examination. Therefore, a total of 68 crowns were evaluated using the CDA criteria. Using this criteria, 54(79.4%) crowns were deemed acceptable while 14(20.6%) were unacceptable and required replacement. In evaluation of colour and surface characteristics, 63(92.6%) crowns were found to be acceptable. The anatomic form of 60(88.2%) crowns was acceptable whereas the marginal integrity was acceptable in 59(86.8%) crowns. Some of the crowns were unacceptable due to multiple reasons (Table 3.18).

**Table 3.18 Evaluation of crowns by CDA criteria**

| Characteristic | Range of excellence n (%) | Range of acceptability n (%) | Correct for prevention (n %) | Replace statim n (%) | Total |
|---|---|---|---|---|---|
| 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 |

### 3.6.4 Periodontal evaluation of crowned teeth

Periodontal health of the crowned teeth was evaluated by assessment of the gingival score, periodontal probing depth, periodontal attachment loss and mobility.

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 (Table 3.19).

**Table 3.19 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%) |

Sixty two (91.2%) teeth had probing depth measurements between 1-3mm, whereas 6 (8.8%) had probing depths greater than three (Table 3.20).

**Table 3.20 Periodontal probing depths for crowned teeth**

| PPD(mm) | n (%) |
|---|---|
| 1 | 16(25.3%) |
| 1.5 | 5 (7.35%) |
| 2 | 19 (27.9%) |
| 3 | 22(32.5%) |
| 4 | 2(2.9%) |
| 5 | 2 (2.9%) |
| 6 | 2(2.9%) |

Fifty three (77.9%) teeth did not have any periodontal attachment loss while 7(10.3%) had attachment loss between 1-2 mm and 8(11.8%) had attachment loss of 3mm. There were no teeth with attachment loss of 4mm and above (Table 3.21). Majority of the teeth [66(97.1%)] did not exhibit any mobility whereas 2 (2.9%) teeth exhibited grade I mobility.

**Table 3.21 Periodontal attachment loss for crowned teeth**

| PAL (mm) | n (%) |
|---|---|
| 0 | 53(77%) |
| 1-2 | 7(10.3%) |
| 3-4 | 8(11.8%) |
| >5 | 0(0%) |

### 3.6.5 Radiographic evaluation for crowned teeth

Sixty eight crowned teeth were evaluated radiographically. The radiographs were examined for radiolucency indicative of caries, periapical radiolucency, endodontic treatment, widening of the PDL space, alveolar bone loss as well as presence and design of root canal posts in the root treated teeth. One (1.5%) of the crowned teeth exhibited evidence of radiolucency consistent with decay whereas 7 (10.3%) exhibited periapical radiolucency. All the 7 teeth exhibiting periapical radiolucency were endodontically treated, on comparison with previous radiographs it was observed that this radiolucency was resolving in all the cases (Table 3.22).

A total of 56 (82.4%) crowned teeth were endodontically treated. Of these, 36(64.3%) had been restored with posts. From patient records it was established that smooth and tapered fibre posts were the material of choice for majority of the teeth accounting for 35(97.2%) of these teeth. In the remaining one case the type of post used was not documented.

A total of 13 crowned teeth (19.1%) exhibited widening of the PDL space. Four of the teeth with widening of periodontal ligament space were endodontically treated (Table 3.22)

**Table 3.22 Radiographic evaluation of crowned teeth**

| | **Yes n (%)** | **No n (%)** | **Total** |
|---|---|---|---|
| Presence of radiolucency indicative of caries | 1(1.5%) | 67(98.5%) | 68 |
| Periapical radiolucency | 7(10.3%) | 61(89.7%) | 68 |
| Root treated | 56(82.4%) | 12(17.6%) | 68 |
| Presence of post | 36(52.9%) | 32(47.1%) | 68 |
| Widening of PDL space | 13(19.1%) | 55(80.9%) | 68 |
| Bone loss | 31(45.6%) | 37(54.4%) | 68 |

### 3.6.6 Success rate of crowns and associated causes of failure

A total of 81 crowns had been provided to patients within the study period. Thirteen (16%) were missing at the time of examination, hence a total of 68 (84%) crowns were evaluated. Upon clinical and radiographic assessment, 54 (66.7%) were considered successful. The success rate was determined as 66.7% (95% CI: 48.89-84.45%).

Fourteen (17.3%) crowns were deemed unacceptable and needed 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.

Information regarding reasons for replacement and causes of failure for the crowns that were missing was sought from the patients. Four (4.9%) crowns were reported to have been lost due to tooth fractures; three of the fractured teeth were subsequently extracted. From the patient records it was established that all the three extracted teeth had been endodontically treated and restored with post crowns. Nine (11.1%) of the crowns had been replaced prior to the study; 5(6.2%) of them due to porcelain fracture, 3(3.7%) due to loss of retention and 1 (1.2%) due to shade mismatch.

Fisher's exact test elicited a statistically significant association 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 (Table 3.23). A chi square test revealed a significant association between the level of training of the clinician and the success of crowns. Crowns fabricated by graduate students had a higher success rate as compared to those fabricated by undergraduate students ($\chi^2$ =9.826, p= 0.003) Table 3.23. Crowns fabricated by interns were not included in the test as they were too few to facilitate any meaningful comparison.

Chi square test yielded no association between the presence of root fillings, presence of posts, position of crown and the success of crowns (Table 3.23).

**Table 3.23 Association between various variables and success of crowns**

| | Success | |
|---|---|---|
| **Characteristics** | **Yes** | **No** |
| **Length of service of crown (months)** | | |
| 0.5 – 24 | 21 | 15 |
| 25 – 48 | 23 | 3 |
| 49 and above | 10 | 9 |
| | *Fisher's Exact Test(2) = 8.846, p = 0.011 | |
| **Level of training** | | |
| Undergraduate level | 10 | 13 |
| Graduate | 43 | 11 |
| | *$\chi^2(1) = 9.826$, p = 0.003 | |
| **Presence of root filling in crowns** | | |
| Yes | 43 | 24 |
| No | 11 | 3 |
| | Fisher's Exact Test(1) = 0.738, p = 0.531 | |
| **Presence of post in crowns** | | |
| Yes | 29 | 15 |
| No | 25 | 12 |
| | $\chi^2(1) = 0.241$, p = 0.807 | |
| **Position of crown** | | |
| Anterior | 28 | 15 |
| Posterior | 26 | 12 |
| | $\chi^2(1) = 0.099$, p = 0.816 | |

Chi-Square Test for Independence (Pearson Chi-Square) was used.

Fishers Exact Test was used.

*p<0.05

### 3.6.7 Complications associated with crowns

Complications most commonly associated with crowns included loss of retention, porcelain fractures and defective margins accounting for 15(18.5%), 9(11.1%) and 9(11.1%) crowns respectively. Sensitivity, discomfort during mastication, caries, tooth fractures and poor esthetics were the other associated complications (Figure 3.10).

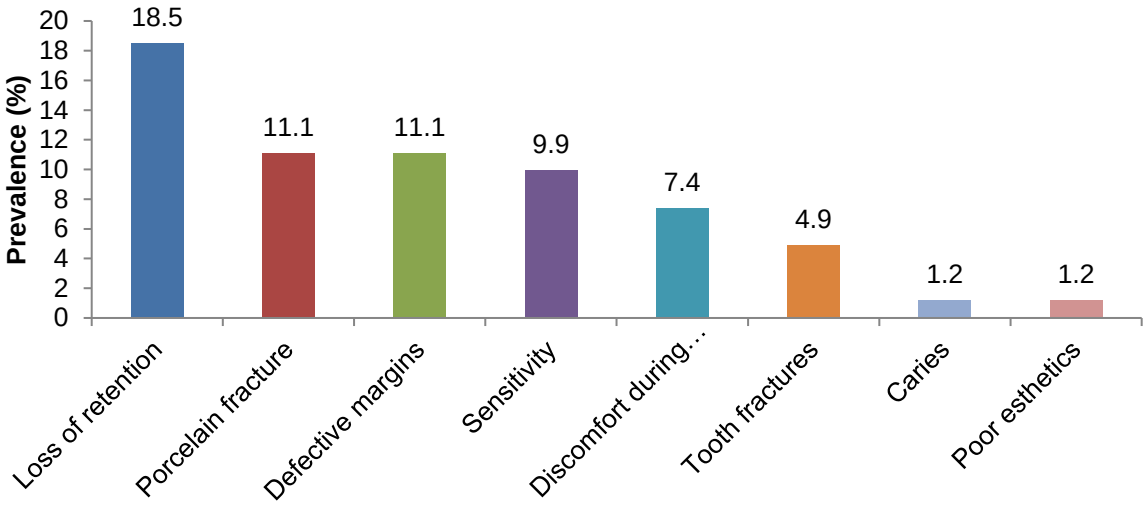


**Figure 3.6 Complications associated with crowns**

Refer to Appendix XI for photographs depicting some of the complications that were associated with crowns (Fig V-VII).

### 3.6.8 Patient satisfaction with crowns

Most patients were pleased with their crowns with 19 (27.9%) indicating that they were very satisfied and 42(61.8%) indicating they were satisfied. Seven (10.3%) were dissatisfied while no participant indicated that they were very dissatisfied (Table 3.24). There was a statistically significant association between success and satisfaction (Fisher's Exact Test = 12.336, p = 0.003) Table 3.25.

**Table 3.24 Patient satisfaction with crowns**

| **Success** | **Very satisfied n (%)** | **Satisfied n (%)** | **Dissatisfied n (%)** | **Very Dissatisfied n (%)** | Total |
|---|---|---|---|---|---|
| Yes | 18 (26.5%) | 34(50%) | 2(2.9%) | 0(0%) | 54(79.4%) |
| No | 1(1.5%) | 8(11.7%) | 5(7.4%) | 0(0%) | 14(20.6%) |
| | 19(28%) | 42(61.7%) | 7(10.3%) | 0(0%) | 68(100%) |

**Table 3.25 Association between success of crowns and satisfaction**

| | **Success** | |
|---|---|---|
| | **Yes** | **No** |
| **Satisfaction rating for crowns** | | |
| Satisfied | 52(96.3%) | 9(64.3%) |
| Dissatisfied | 2(3.7%) | 5(35.7%) |
| | *Fisher's Exact Test(1) = 12.336, p = 0.003 | |

*p<0.05

# CHAPTER 4: DISCUSSION

## 4.1 Introduction

Evaluation of treatment outcomes remains critical in provision of scientific evidence which informs treatment planning and patient education for decision making. This study involved evaluation of crowns and fixed partial dentures provided at the School of Dental Sciences (UON) over a seven year period. A total of 97 patients were evaluated, these patients had been rehabilitated with a total of 81 crowns and 69 fixed partial dentures. A total of 62 (69.3%) patients were women, this pattern is similar to those reported in several studies whereby more women seek dental treatment as compared to men.[44, 49, 51]

## 4.2 Fixed partial denture design

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 school clinics and among general dental practitioners. Hochman et al[44] evaluated a total of 50 FPDs out of which 40% were three unit and 26% were four unit FPDs. Vaulderhaug,[51] evaluated 108 bridges out of which 59(54.6%) had between two and four units. Leempoel et al, [16] 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.[5] 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 Walton et al, [31] 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. [5]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 teeth.[5] 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.

### 4.3 Materials used in the fabrication of prostheses

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.[13] This perhaps explains why it was the material of choice for 78(96.3%) crowns and 68(98.6%) 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. 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 increasing 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.

Newer ceramics with improved mechanical properties have been developed to overcome this limitation. Two of the most commonly utilized high strength ceramics include lithium disilicate and zirconia.[57]A systematic review conducted to study the outcomes of lithium disilicate crowns and fixed partial dentures revealed a 5 year cumulative survival rate of 97.8% and 78.1% for crowns and FPDs respectively.[58] The same study revealed 10 year cumulative survival rate of 96.7% and 70.9% for crowns and FPDs respectively. Most of the failures occurred in the posterior region for both types of prostheses. The survival rates for the crowns was comparable to metal-ceramic crowns whereas that of FPDs was lower.

Zirconia, an exceptionally strong ceramic, has become the material of choice for all ceramic bridge frameworks. Framework failures with this material are much lower when compared with other ceramics, however they may still occur.[59] When they do occur, they generally involve connectors of prostheses of four or more units or second molar abutments.[60] This material is highly opaque and veneering with more translucent ceramics is required. Veneer fractures are a common complication.[61]

It is probable that the above mentioned factors of reduced survival rate and limited long term studies could have contributed to the lack of utilization of all ceramic bridges in our study population. However, despite studies having shown high short term and mid-term survival rates for all ceramic crowns their utilization was very low, perhaps 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 contributed. 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.

## 4.4 Success rate of crowns and fixed partial dentures

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 school which was 92% for a mean lifespan of 75months.[44]

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 Cheung 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.[44,49,51] Hochman et al,[44] reported a failure rate of 6% for a mean lifespan of 6.3 years whereas Libby et al,[49] reported a failure rate of 15% for a mean length of service of 16 years. Vaulderhaug et al,[51] 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.[62] The fact that it 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 avail themselves 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 were not evaluated.

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.[63]These challenges may have contributed to the large number of defective margins and porcelain fractures encountered in this study affecting a total of 22 (14.6%) and 15(10%) prostheses respectively. These results can be contrasted with those of Libby et al, [49] 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. They also reported routine use of metal occlusal contacts and gingival collars.

Non-vital teeth have been shown to exert a negative influence on the success and survival of crowned teeth and FPD abutments.[16,44] 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.

The perception of success by patients has been known to differ from that of clinicians. It was interesting to note that patient attitude to the prostheses did not always correlate with the clinician's findings. Patients were satisfied with 19(67.9%) out of 28 prostheses deemed to be unsuccessful by the clinician whereas in 3 of the cases a prostheses was deemed to be a success by the clinician but the patient was dissatisfied with it. This indicates that patient satisfaction may not be a reliable indicator of success.

## 4.5 Complications associated with crowns and fixed partial dentures

Defective margins, porcelain fractures and loss of retention were the most common complications associated with crowns. These findings compared well with a systematic review by Goodacre et al,[29] who reported that porcelain fractures and defective margins were

among the most common complications associated with crowns. However, the findings differed slightly in that need for endodontic treatment was highlighted by Goodacre et al as among the most common complications, in this study there was no incidence of a crowned tooth that was in need of endodontic treatment. This may partly be attributed to the relatively short mean length of service captured in the study. Biological complications like caries and loss of vitality have been shown to occur after a long duration of time. One study,[48] quoted an average of 9.7 years whereas the mean length of service in our study was 3 years.

Absence of a crowned tooth in need of endodontic treatment in our study may also be attributed to the fact that it is institutional practice within the school to perform endodontic treatment on teeth with history of pulp capping and very large restorations prior to crowning. This serves to minimize the occurrence of this complication. Most of the crowned teeth that were evaluated were already root treated (82.4%), indicating reduced tendency to crown vital teeth at the school. This too may have contributed to the absence of crowned teeth with loss of vitality.

Sensitivity, defective margins and porcelain fractures were the most common complications associated with FPDs. These findings differed from those reported by Goodacre et al, [29] in the systematic review whereby caries, need for endodontic treatment and loss of retention were the most common complications associated with conventional FPDs.

The low incidence of caries and loss of vitality in this study may be explained by the comparatively shorter mean length of service for the FPDs (3.5 years). It may also be attributed to careful patient selection for crowns and FPDs, the population evaluated generally exhibited good oral hygiene with a low average plaque score of 1.4. This could be an indicator that patients selected for these kinds of treatment were well motivated patients maintaining good oral hygiene hence at low caries risk. On the other hand, presence of

defective margins in many of the failed restorations could imply that in the long-term this crowned and abutment teeth would be susceptible to caries and loss of vitality.

Porcelain fractures and defective margins were common complications for both crowns and FPDs. Intra-oral porcelain has the potential to fracture; fracture may occur due to several reasons which include high occlusal forces, trauma, incompatible coefficients of thermal expansion between the porcelain and the metal alloy, low-elastic modulus of the metal alloy, improper design and micro-defects within the porcelain material.[64] This complication usually presents an esthetic challenge due to exposure of underlying metal, more so in the esthetic zone.

A number of repair systems exist for the repair of fractured porcelain, these systems usually involve bonding of resin composite to the fractured porcelain. This technique has poor long term prognosis as a result of decreasing bond strength of composite to porcelain over time, increased wear encountered on the composite as compared to porcelain and poor colour stability associated with resin composites. [64] Moreover, due to differing optical properties, colour matching porcelain to composite is difficult hence this technique many times results in inferior esthetics.

Due to the above mentioned challenges associated with porcelain repair, many prosthesis that present with fractured porcelain are usually indicated for replacement. In this study, only one prosthesis with porcelain fracture was indicated for repair, this was a 5 unit bridge and the fracture was minimal, most of the prostheses with porcelain fractures were indicated for replacement due to the extent of the fracture. Some of the prostheses with porcelain fractures also presented with other faults within the restoration like marginal defects hence informing the decision to remake as opposed to repair.

Accurate marginal fit of indirect restorations is critical for long term success. This is because ill-fitting margins will render the tooth more susceptible to cement dissolution, once this

occurs marginal leakage ensues and this usually results in secondary caries and may lead to loss of vitality of the abutment if undetected. Ill fitting margins also result in plaque retention which also predisposes the abutment to recurrent caries. Defective subgingival margins may compromise gingival health by causing an alteration in local bacteria.

All crowns and FPDs within our study that were noted to have defective margins that could not be corrected were indicated for replacement. Defective margins may present as marginal gaps, positive or negative margins. Positive margins in the absence of a gap can be corrected. However marginal gaps and negative ledges pose a much bigger problem that is difficult to correct and often necessitate replacement of the prosthesis.[65]

Defective margins may arise due to clinical or laboratory errors. Clinical errors may arise due to improper preparation of finish lines or inadequate retraction of the gingiva during impression taking. Presence of air bubbles within the margin captured on the impression may also contribute to these errors. Laboratory errors on the other hand may arise due to poor die trimming, surplus untrimmed porcelain/wax, difficulty in identification of the finish line, chipped dies and failure to utilize a spacer which results in a tightly fitting crown that lifts off during cementation resulting in a marginal gap.[65]A critical analysis of the clinical and laboratory procedures at the School of Dental Sciences where this study was conducted maybe necessary to facilitate determination of the source of these errors with an aim to minimize the presence of defective margins in crowns and FPDs provided to patients.

## 4.6 Periodontal health associated with crowned teeth and fixed partial denture abutments

Poor marginal adaptation, sub-gingival margin placement and over-contoured crowns can contribute to localized periodontal inflammation. Vaulderhaug et al,[66] 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

inflammed 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.[5]

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.[67] 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

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 duration had higher success rates.

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.

5. 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.

## RECOMMENDATIONS

1. There is need to institute measures to improve the outcomes of crowns and fixed partial dentures provided to patients at the School.
2. An audit of clinical and laboratory procedures for crown and bridge work at the School of Dental Sciences is recommended to establish and mitigate possible sources error which may lead to complications and failures.
3. Establishment of a proper recall system for all patients who have undergone fixed prosthodontic work is recommended to enable early detection and management of associated complications.
4. Further studies are recommended to establish the factors that influence choice of materials for crown and bridgework within the institution since the materials used play a role in the final outcome as pertains to success rate and complications associated with these prostheses.

## BENEFITS OF THE STUDY

Information gathered regarding various outcomes will allow clinicians to arrive at suitable treatment options with good prediction of expected outcome.

Replacement or modification of prostheses found to be faulty was done, this served to prevent occurrence of more catastrophic failures that would occur if these complications had gone undetected.

Knowledge of the associated complications and causes of failure revealed the areas in the various stages of treatment that need to be worked on to improve the quality and longevity of crowns and FPDs provided to patients at the institution.

## STUDY LIMITATIONS

Inability to contact candidates who had changed their contacts and a relatively low response (54%) from the patients who were called reduced the number of patients and subsequently that of the prostheses evaluated.

The retrospective nature of the study precluded determination of exact timing of occurrence of adverse events. Additionally relying on patient reports regarding reason for replacement or removal of missing restorations was subject to recall bias.

The radiographic method employed to evaluate the crowned and abutment teeth was two dimensional hence reduced sensitivity for the various parameters that were being investigated as compared to what would be achieved with three-dimensional imaging. Two dimensional imaging was employed to reduce patient radiation exposure and due to financial considerations.

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# APPENDICES

## APPENDIX I: CONSENT INFORMATION DOCUMENT

I, Dr Laura Edalia of the University Of Nairobi, School of Dental Sciences, am conducting a study to evaluate crowns and conventional fixed partial dentures provided to patients at the School of Dental Sciences, University of Nairobi. Participation in the study is voluntary and you are at liberty to decline your participation without any dire consequences.

RISKS: There are no risks involved in the study as there are no invasive procedures to be performed; hence there is no risk of psychological or bodily harm.

BENEFITS: Information gathered from this study will provide scientific evidence for future treatment planning and consent acquisition. In case of any pertinent findings, you will be given advice regarding the condition and will be referred for relevant management.

CONFIDENTIALITY: The information obtained will be treated with utmost confidentiality. In case of any problems or for clarification of ethical issues, please contact the Kenyatta National Hospital/ University of Nairobi Ethics, Research and Standards Committee.

## APPENDIX II: HABARI KUHUSU IDHINI

Mimi, Dk Laura Edalia wa Chuo Kikuu cha Nairobi, Shule ya Sayansi ya meno, nafanya utafiti ili kutathmini taji na meno bandia zinazotolewa kwa wagonjwa katika Shule ya Sayansi ya meno, Chuo Kikuu cha Nairobi. Kushiriki katika utafiti huu ni kwa hiari na wewe ukona uhuru wa kutoshiriki bila madhara yoyote.

HATARI: Hakuna hatari ya madhara ya kisaikolojia au kimwili kwa kushiriki katika huu utafiti .

FAIDA: Taarifa zitazo kusanywa kutoka utafiti huu zitatoa ushahidi wa kisayansi kwa ajili ya matibabu ya baadaye, mipango na upatikanaji ridhaa. Katika kesi ya matokeo yoyote muhimu, wewe utapewa ushauri kuhusu hali hiyo na kuelekezwa kupokea matibabu.

USIRI: Taarifa zitakazopatikana zitakuwa siri. Ukiwa na jambo la kutatiza kuhusu utafiti huu waweza kuwasilianana Kenyatta National Hospital/University of Nairobi Ethics, Research and Standards Committee.

# APPENDIX III: CONSENT FORM

I ……(initials) having understood the purpose, benefits and risks of the study titled 'An evaluation of crowns and conventional fixed partial dentures provided to patients at the School of Dental Sciences, University of Nairobi' willingly accept to participate.

I understand that all the information I give will be treated with strict confidentiality and will be used for the sole purpose of this research.

In case of any clarifications or concerns regarding the study you may contact the investigator, the supervisors or the KNH/UON Ethics, Research and Standards Committee using the following contacts:

Dr Laura Edalia: Cell phone number- 0722928375, email address- lauraedalia2000@yahoo.com

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Dr Regina Mutave: Cell phone number- 0722754481, email address – mutave@uonbi.ac.ke

KNH/UON-ERC: Tel- 020 726300-9, email address- uonknh_erc@uonbi.ac.ke

Signature of participant……..

Date……

## APPENDIX IV: FOMU YA IDHINI

Mimi……..(Initials) baada ya kuelewa makusudi, faida na hatari ya utafiti yenye jina la 'Tathmini ya taji na meno bandia zinazotolewa kwa wagonjwa katika Shule ya Sayansi ya meno, Chuo Kikuu cha Nairobi' nakubali kushiriki kwa hiari.

Naelewa kwamba taarifa zote na wapa zitawekwa kwa usiri mkubwa na zitatumika kwa madhumuni ya utafiti huu pekee.

Ukiwa na maswali kuhusu utafiti huu waweza kuwasiliana na mtafiti, wasimamizi wake au KNH/UON Ethics, Research and Standards committee kupitia nambari zifwatazo:

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Saini……

Tarehe……..

## APPENDIX V: QUESTIONNAIRE

1. Age:
2. Gender:
3. Occupation:
4. Highest level of education attained?
    a) Primary school
    b) Secondary school
    c) Tertiary level
5. How often do you brush your teeth?
    a) Once a day
    b) Twice a day
    c) More than twice a day
    d) Other……
6. Do you use the following oral hygiene aids?
    a) Regular dental floss
    b) Superfloss
7. How often do you visit a dentist?
    a) Annually
    b) Bi-annually
    c) On need basis
    d) Other……
8. Do you suffer from any of the following chronic illnesses?
    a) Diabetes mellitus
    b) Heart disease
    c) Hypertension

d) Other…….

9. Do you experience the following symptoms from the crown/fixed partial denture in your mouth?

| | Yes | No |
|---|---|---|
| a. Pain | | |
| b. Sensitivity | | |
| c. Discomfort during mastication | | |

10. How would rate your overall satisfaction with the crown/fixed partial denture in your mouth?

    a) Very satisfied

    b) Satisfied

    c) Not satisfied

    d) Very dissatisfied

11. Is there history of decementation of the crown/fixed partial denture

    a) Yes

    b) No

## APPENDIX VI: DATA COLLECTION FORM

i. Type of restoration
   a) Crown
   b) Fixed partial denture

ii. Location of restoration
   a) Anterior
   b) Posterior

iii. Fixed partial denture design
   a) Cantilever bridge
   b) Fixed-fixed bridge
   c) Resin bonded bridge
   d) Fixed-movable bridge

iv. Span of prostheses
   a) 2 unit bridge
   b) 3 unit bridge
   c) 4 unit bridge
   d) 5 unit bridge
   e) More than 5

v. Occlusal scheme
   a) Canine guided
   b) Group function

vi. Evaluation of surface characteristics and colour of prostheses(CDA criteria)
   a) Range of excellence
   b) Range of acceptability

State any feature deviating from

ideal……..……

……

……

c) Correct for prevention.

State feature to be

corrected……..

……

……

d) Replace statim

Give reasons for replacement……..

……..

……..

vii. Evaluation of anatomic form

a) Range of excellence

b) Range of acceptability

State any feature deviating from

ideal……..……

……

……

c) Correct for prevention.

State feature to be

corrected……..

……

……

d) Replace statim

Give reasons for replacement……..

……..

viii. Evaluation of marginal integrity(CDA criteria)

a) Range of excellence

b) Range of acceptability

State any feature deviating from

ideal……..……

……

……

c) Correct for prevention.

State feature to be

corrected……..

……

……

d) Replace statim

Give reasons for replacement……..

……..

……..

ix. Abutment/crowned tooth periodontal health evaluation

| Tooth | GI score | PAL(mm) | PPD(mm) | Mobility |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

x. Radiographic evaluation

| | Yes | No |
|---|---|---|
| a) Evidence of radiolucency consistent with caries | | |
| b) Evidence of periapical radiolucency | | |
| c) Widening of PDL space | | |
| d) Presence of root filling | | |
| e) Presence of post | | |

xi. Plaque score

| | 16 | 21 | 24 | 36 | 41 | 44 |
|---|---|---|---|---|---|---|
| Buccal | | | | | | |
| Lingual | | | | | | |

Overall plaque score……..

xii. Chart

a) Decayed teeth (D)

b) Missing teeth (M)

c) Filled teeth (F)

| 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
| | | | | | | | | | | | | | | | |

The following information to be established from the patient notes on file:

xiii. Length of service of prostheses in months……

xiv. Material used for fabrication of crown/ FPD

a) All ceramic

b) All metallic

c) Metal-ceramic

d) Other

xv. Type of post

a) Metallic

b) Fibre post

c) Ceramic

xvi. Post design

a) Parallel

b) Tapered

c) Smooth

d) Threaded

xvii. Material used for core build up

a) Amalgam

b) Resin composite

c) Resin modified Glass ionomer cement

d) Conventional Glass ionomer cement

xviii. Luting cement used to cement post

a) Zinc phosphate

b) Resin modified glass ionomer cement

c) Resin cement

d) Other

xix. Luting cement used for crown/ FPD

a) Zinc phosphate

b) Resin modified glass ionomer cement

c) Resin cement

d) Other

xx. Level of training of clinician

a) Undergraduate student

b) Graduate student

c) Intern

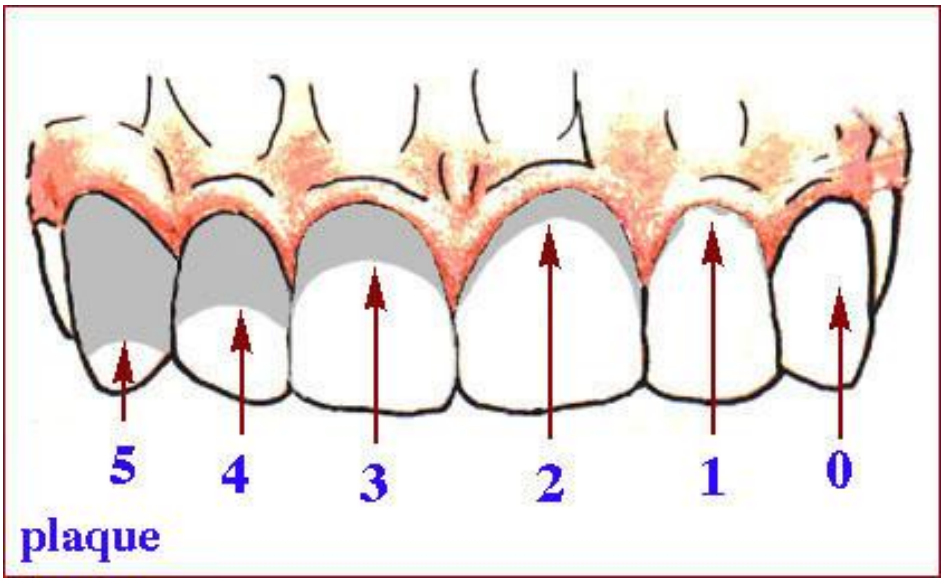
# APPENDIX VII :CDA CRITERIA

| Surface and colour | Anatomic form | Marginal integrity |
|---|---|---|
| **R: Range of excellence** | | |
| Surface of restoration is smooth | Restoration contour is in functional harmony with adjacent teeth and soft tissues with good individual anatomic form. | No visible evidence of crevice or margin into which explorer will penetrate. |
| No irritation of adjacent tissue | | Satisfies principles of margin placement |
| There is no mismatch in color or translucency between restorations and adjacent teeth | | No discoloration on margin between restoration and tooth structure. |
| **S:Range of acceptability** | | |
| SRO Surface of restoration is slightly rough or pitted | SOCO Restoration overcontoured slightly. | SCR Visible evidence of slight marginal discrepancy with no evidence of decay. |
| SMM Slight mismatch between shade of restorations and adjacent tooth or teeth(within the normal range of tooth colour) | SUCO Restoration slightly undercontoured | SDIS Discolouration on margin between restoration and tooth structure. |
| | SOH Occlusion is not totally functional( height reduced locally) | |
| | SMR Marginal ridges slightly undercontoured | |
| | SCO Contact slightly open | |
| | SFA Facial flattening present | |
| | SLG Lingual flattening present | |
| | SAF Anatomic form of the pontic may cause food retention; no irritation of soft tissues | |
| | SOC Occlusal contour not continuous with that of cusps and planes | |
| | SPX Interproximal cervical area slightly undercontoured. | |

| Surface and colour | Anatomic form | Marginal integrity |
|---|---|---|
| **T: replace or correct for prevention** | | |
| TGI Surface grossly irregular, not related to anatomy and not subject to correction. | TUCO Restorations grossly undercontoured. | FAM Faulty margins that cannot be properly prepared. |
| TMM Mismatch between restoration and adjacent teeth outside normal range of colour, shade or translucency. | TOCO Restoration grossly overcontoured. | TPEN Penetrating discoloration along margin of restoration in pulpal direction. |
| TPIT Surface deeply pitted, irregular grooves that cannot be refinished. | TET occlusion affected | TCEM Retained excess cement |
| | TCO Contact is faulty | TMD visible ditching along the margin extending to the DEJ. |
| | TOV There is marginal overhang. | TMB ditching along the margin extending to the center base. |
| | TAF Anatomic form of pontic likely to result in food retention, causing irritation to soft tissue or caries in abutments. | |
| | TDE Dentition is exposed | |
| | TBA base is exposed | |
| | TOC Occlusion is affected | |
| | TPX contact is faulty- self correction unlikely | |
| **V: Replace statim** | | |
| VSF surface is fractured | VTO Traumatic occlusion | VMO Mobile restoration |
| VGP There are gross porosities in crown material. | VUO Gross underocclusion or restoration. | VFR Fractured restoration |
| VSD Shade in gross disharmony with adjacent teeth. | VPN Restoration causes unremitting pain in tooth or adjacent tissue. | VCAR caries continuous with margin of restoration. |
| VFK Surface is flaking | VDM Damage is now occurring to tooth, soft tissue or supporting bone. | VTF Tooth structure is fractured. |
| VUN esthetically displeasing color, shade and/or translucency. | VMIS Restoration is missing | |

## APPENDIX VIII: TURESKY'S PLAQUE INDEX (1970)

| Scores | Criteria |
|---|---|
| 0 | No plaque |
| 1 | Separate flecks of plaque at the cervical margin of the tooth |
| 2 | A thin continuous band of plaque (up to one mm) at the cervical margin of the tooth |
| 3 | A band of plaque wider than one mm but covering less than one-third of the crown of the tooth |
| 4 | Plaque covering at least one-third but less than two-thirds of the crown of the tooth |
| 5 | Plaque covering two-thirds or more of the crown of the tooth |



## APPENDIX IX: LOE &SILNESS GINGIVAL INDEX (1963)

Score 0 = Normal gingiva.

Score 1 = Mild inflammation - slight change in color, slight edema. No bleeding on probing.

Score 2 = Moderate inflammation - redness, edema, glazing. Bleeding on probing.

Score 3 = Severe inflammation - marked redness and edema, ulceration. Tendency toward spontaneous bleeding

# APPENDIX X: ETHICAL APPROVAL

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Ref: KNH-ERC/A/466

11th November 2015

Dr. Laura Edalla
V60/75832/2014
Dept. of Conservative and Prosthetic Dentistry
School of Dental Sciences
University of Nairobi

Dear Dr. Edalla

**Research proposal: Evaluation of crowns and conventional fixed partial dentures provided to patients at the School of Dental Sciences, University of Nairobi (P680/10/2015)**

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH-UoN ERC) has reviewed and **approved** your above proposal. The approval periods are 11th November 2015 – 10th November 2016.

This approval is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH-UoN ERC before implementation.
c) Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH/UoN ERC within 72 hours.
e) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
f) Clearance for export of biological specimens must be obtained from KNH/UoN-Ethics & Research Committee for each batch of shipment.
g) Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/or plagiarism.

For more details consult the KNH/UoN ERC website **http://www.erc.uonbi.ac.ke**

Yours sincerely,

**PROF. M.L. CHINDIA**
**SECRETARY, KNH-UoN ERC**

c.c. The Principal, College of Health Sciences, UoN
The Deputy Director CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information, KNH
The Dean, School of Dental Sciences, UoN
The Chair, Dept.of Conservative and Prosthetic Dentistry,UoN
Supervisors: Dr. B.A. Kassim, Dr. Fred Otieno

# APPENDIX XI: PHOTOGRAPHS

Figure I: Porcelain fracture in a 5 unit bridge

Figure II: Porcelain fracture in a 3 unit bridge

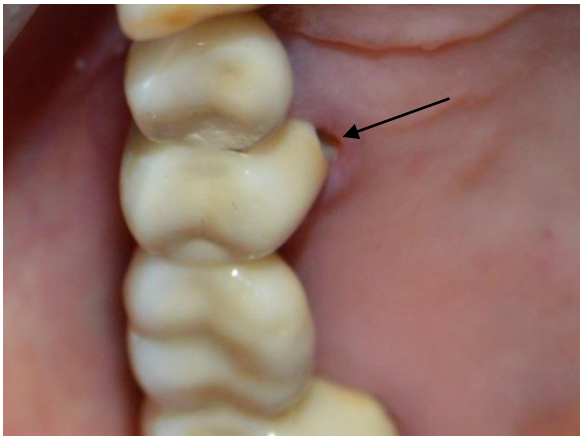

Figure III: Caries in a 4 unit bridge

Figure IV: Gingival recession on a FPD abutment

Figure V: Loss of a crown due to caries

Figure VI: Central incisor after post-crown decementation.

Figure VII: Decemented post-crown from a central incisor