

# Mapping of tooth loss profiles and the variety of removable partial denture designs fitted to patients in a University dental school clinic in Trinidad

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## ABSTRACT

**Background:** Clinicians are continually challenged to improve the standard of treatment. Careful measurements and designs, based on knowledge of tooth loss patterns and biomechanical principles, will determine the overall quality of removable prostheses.

**Objectives:** This study maps the pattern of tooth loss in a sample of patients and the most efficient designs employed for their cobalt-chrome removable prosthesis.

**Material and methods:** Data was collected from gypsum casts, metal castings, and prescriptions sent to dental technicians. The sample included both men (44) and women (109). Information was obtained on their Kennedy classification, number of missing teeth in the maxilla and the mandible, the type of major connector fitted, and when additional indirect retainers with clasps were incorporated into the frame. The significance of the association between pairs of these categorical variables was tested by a Chi Square test.

**Results:** Patients with maxilla loss (82%) had mostly (54%) 6 to 10 missing teeth and were assessed principally (78%) as exhibiting Kennedy Class II or III patterns. Most (77%) of those missing teeth in their mandible (66%) were assessed as either Class I or Class II. The Anterior-Posterior (70%) in the maxilla and the Lingual Bar (74%) in the mandible were the most common fitted connectors. Indirect retainers were used for patients with maxilla (78%) or mandible (96%) tooth loss to provide extra stability.

**Conclusion:** Additional components incorporated in the Cobalt-Chrome frame increased the biomechanical efficiency of the appliance by reducing destructive forces, caused by the torque on the abutment teeth.

**Key words:** Removable prosthodontics, indirect retainers, partial denture design, pattern of tooth loss, cobalt-chrome dentures

## Introduction

There is a distinct pattern of tooth loss across the world. This is evident by the most common patterns of missing teeth, which correlate with the differences in the frequencies and types of partial denture designs most often employed in dentistry practices in different countries. In Wisconsin, North America, the most common type of partial denture fabricated was Class I. <sup>[1]</sup> This was found in another study with patients from a dental school in California. <sup>[2]</sup> In these studies 38.4% and

40% of the Wisconsin and California samples respectively were found to be Class I (for the maxilla and mandible prostheses in toto). A report from a study of patients in Greece last year indicated that 50.5% of that sample was also Class I in the maxilla and 70% Class I in the mandible. <sup>[3]</sup> This means that the majority of these persons are missing posterior teeth either from both sides of one jaw or from both jaws. A different pattern was reported in another study of 740 cobalt chromium dentures in a Saudi Arabian dental school. <sup>[4]</sup> In this

instance, the denture for the Kennedy Class III tooth loss pattern was the one most often fabricated. Similar results were found in another dental school in Jordan.<sup>[5]</sup> This study showed that for both the upper and lower jaws, the appliance for the Kennedy Class III was the most commonly made. The trend here is that dentures are predominantly provided for people who are still retaining some of their posterior teeth. These published studies contain information on the pattern of tooth loss and the ultimate denture design.

All across the world there is, in general, an overall increase in fabrication and use of partial dentures.<sup>[6]</sup> There is also a positive association between wearing dentures and oral health-related quality of life.<sup>[7]</sup> However, there are opposing studies which claim that denture quality has a minimal effect on the oral health-related quality of life.<sup>[8]</sup> This suggests that there may be a certain amount of acceptance of dentures which may or may not be properly fabricated. Published reports show conclusively that a significant percentage of dentures being used by patients do have defects.<sup>[9,10]</sup> These include fractured clasps and broken connectors – both minor and major.<sup>[11]</sup>

There are many factors which contribute to the success of partial dentures. These include both patient-specific factors and denture design. It is generally accepted that the indicators for persons requiring dentures are the absence of oral disease and the presence of sound abutment teeth.<sup>[12]</sup> The Cobalt-Chrome frames should incorporate components that provide a stable support, and should all be designed for function, the promotion of oral health, and the preservation of the remaining oral structures.<sup>[13]</sup>

This study maps the tooth loss profile of patients attending the University of the West Indies Dental Clinic at the Eric Williams Medical Sciences (EWMS) Teaching Hospital in Champs Fleurs, Trinidad. It looks too at the removable partial denture (RPD) designs chosen to fit particular tooth loss patterns by the staff in the Prosthetic Unit.

This unit is a part of a polyclinic that is primarily involved in the undergraduate training of students reading for the Doctor of Dental Surgery degree. The training in removable prosthodontics begins as a pre-clinical course in the second semester of the students' second year and is completed at the end of the first semester in the third year. There are two full-time and one part-time specialist-trained prosthodontists servicing the clinic. There are also numerous full-time and part-time instructors who supervise students with their clinical procedures. These instructors include persons who were trained in different schools in the US and the UK as well as former graduates from this dental school. The patients who attend the prosthodontic clinic are for the most part elderly, usually referrals from other clinics, and often financially challenged. All ethnic groups are represented in the patient population, all of whom live in Trinidad and Tobago, although some may have originated from other countries in the greater Caribbean region. This study is intended to be a part of a larger Public Health initiative which will look to measure the role of oral health in general health and well-being, with a view to managing this latter, via education on preventative practices targeted to fit the problems observed.

In addition to mapping their demographics and tooth loss patterns among the patients in the clinic, one of the

aims of this study was to see if particular maxilla or mandible tooth loss patterns could be traced to the partial denture designed for a patient. The tooth loss patterns are represented by the number of the patient's missing teeth and the Kennedy Classification assessed. We looked both at the type of major connector fitted and at whether or not an indirect retainer was used.

### Material and methods

There were no human participants and no animals used in this research. Ethical approval was given for this research from the University of the West Indies Ethics Committee reference number: EC65: 21/12 – 06/07-approved project number: AH01/05/07. Written consent was obtained from participants in this study for their information to be stored in the hospital database and used for research.

Information was obtained from the prescription forms of a sample of 153 patients, including 44 men and 109 women, as well as from gypsum casts and from the Cobalt-Chromium dentures that were ultimately produced. It should be noted that the sample represents nearly all the patients visiting the clinic in a certain period. The disproportionate distribution of men and women reflects the actual patient sex distribution and not what was chosen for the sample. The data collected included the Kennedy classification, the number of missing teeth in the maxilla and in the mandible, the type of major connectors used and the situations where indirect retainers were incorporated into the frame. Chi Square tests of association were used to estimate which pairs of these categorical variables had significant correlations. The samples are further broken out by sex to see if the overall trends persisted in the

men and women sub-samples. The sub-group of women was larger and sometimes its dominant trend controlled what was observed in the overall sample but not always, as is shown in Table 1. Separating the sub-samples, though, allowed each group to be tested statistically and validly without influence from the other

### Results

#### **Patient Profiles:**

Women constituted most (71.2%) of the study sample, with 66% and 82% of the overall sample having maxilla or mandible tooth loss respectively. When viewed collectively, patients missing teeth in the maxilla fell mostly in the categories of 6 to 10(54%) or 1 to 5(39%) missing teeth, with only very few (7%) having more than 10 missing teeth. These patients were assessed either as Kennedy Class I (20 %), Class II (34.5 %), Class III (43.5 %), or Class IV (2 %) and fitted with one of 4 major connectors: Anterior-posterior (70%), U-shaped (7%), Palatal Strap (8%) or Palatal Plate (15%). Most (78%) of these patients were also fitted with an indirect retainer. Those patients in the sample with mandible tooth loss had mainly 1 to 5(56%) or 6 to 10(36%) missing teeth; were classed as I (35 %), II (42 %), III (22%), or IV (1%); and fitted with either a Lingual Bar (74%) or Lingual Plate (26%) major connector, with an indirect retainer being used, in addition to the connector, with 96% of the patients.

#### **Removable Partial Denture Design Trends**

The Chi Square test of independence is used to test for associations between pairs of categorical variables. Non-significant tests imply the two variables are independent of each other. Significant tests are found when the two variables are associated. Such an

association is found when the frequency distribution across the categories of one variable in the pair changes from one category to the next of the other variable.

The results of the significant Chi Square tests are illustrated graphically in the figures. In these the distinct frequency distributions for one variable can be seen from one category to the next of the second. Significant correlation was found between the number of missing teeth and the Kennedy classification in the mandible (Figure 1a), the type of major connector used in the mandible (Figure 1b) and the use of indirect retainers in the maxilla (Figure 1c).

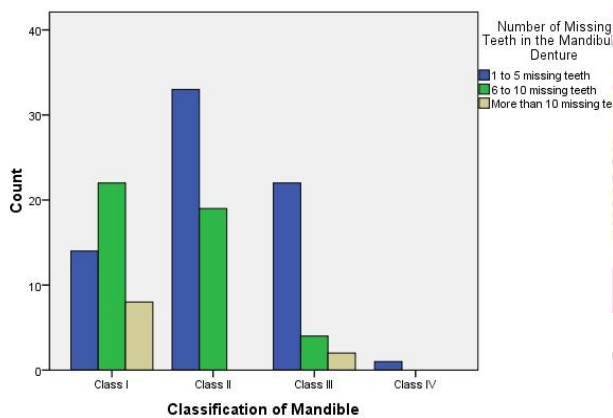


Fig. 1a Significant correlation ( $p=0.000$ ): different patterns of missing teeth in the mandible are seen for patients in different Kennedy Classes

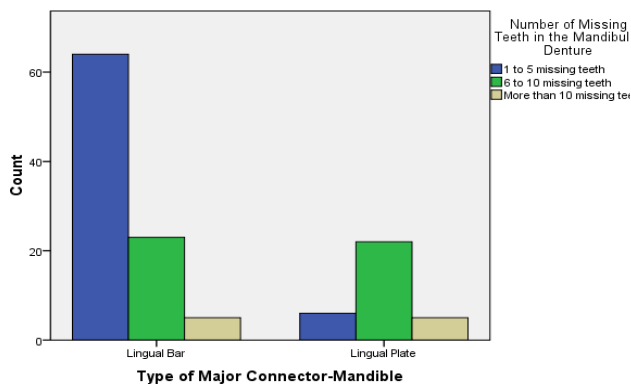


Fig. 1b Significant correlation ( $p=0.000$ ): different patterns of missing teeth in the mandible are seen for patients fitted with either the Lingual Bar or Lingual Plate major connectors

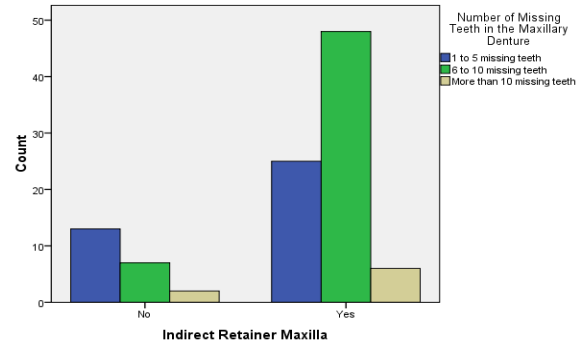


Fig. 1c Significant correlation ( $p=0.046$ ): different patterns of missing teeth in the maxilla are observed in patients fitted or not fitted with additional indirect retainers

In addition to these, significant correlation was found also between the Kennedy classification of the patient and the type of major connector employed in the maxilla denture (Figure 2a) or in the mandible denture (Figure 2b) and the use of indirect retainers in the maxilla. (Figure 2c)

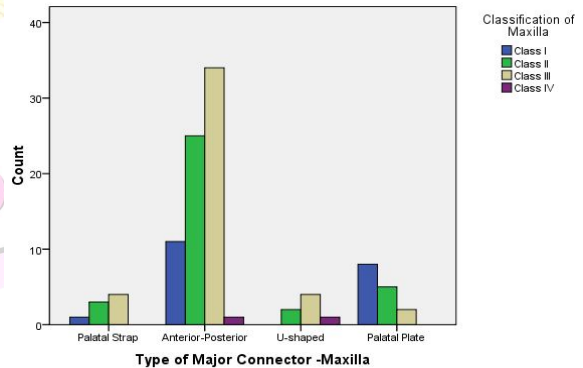


Fig. 2a Significant correlation ( $p=0.014$ ): the distribution of patients across the 4 Kennedy classes is different for each of the 4 different types of major connector fitted in the maxilla

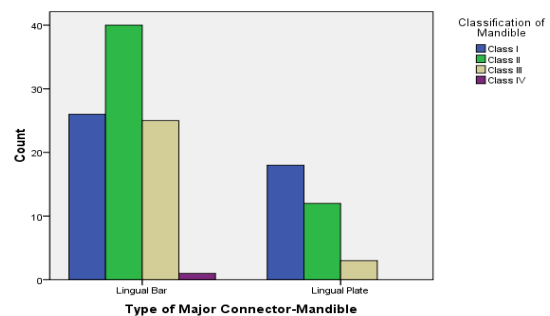


Fig. 2b Significant correlation ( $p=0.03$ ): the distribution of patients across the 4 Kennedy classes is different for each of the two different types of major connector fitted in the mandible

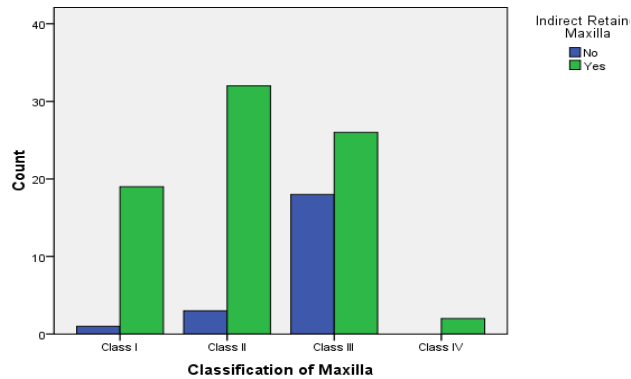


Fig. 2c Significant correlation ( $p=0.001$ ): The ratio of patients fitted/not fitted with an additional indirect retainer is different for patients in each of the 4 Kennedy Classes

Table 1 is used to detail the actual percentages of patients in the main categories as well as to summarize the significant associations and the trends observed for the whole sample and for the men and women sub-groups separately.

In Table 1, the first grouping summarized the trends seen with missing teeth. Next are the associations between the Kennedy Classifications for the maxilla and the mandible with the major connectors applied. Finally, situations associated with the use of indirect retainers are assessed. Significance is tested at the 5% critical level ( $\alpha = 0.05$ ). Those tests which are significant ( $p < 0.05$ ) are designated in the table as S. When there is independence of the two variables being compared, the test is not significant.

The number of missing teeth is not significantly correlated with the Kennedy Classification or with the type of major connector used for the maxilla either when the whole group of patients is considered or when the individual men and women sub-groups are tested. For the mandible, however, the number of missing teeth is significantly correlated with both the Kennedy classification (for the whole group

of patients ( $p=0.000$ )-Figure 1a and for the women alone ( $p=0.000$ ) but not for the men ( $p=0.331$ ) and with the type of major connector used (significant for the whole group ( $p=0.000$ )-Figure 1b as well as for both the women ( $p=0.000$ ) and men ( $p=0.011$ ) sub-groups). Most or all of the women in the sample who were assigned to Kennedy Classes II (71%), III (90%) and IV (100%) had 1 to 5 missing teeth. However, those in Class 1 had significantly more missing teeth with 46% of patients having 6 to 10 missing teeth and 22% more than 10 missing teeth. In almost every patient, for women or men, the Lingual Bar connector was used mostly in patients with fewer (1 to 5) missing teeth and the lingual plate mostly in those with 6 to 10 or more missing teeth.

The Kennedy Class into which the patient was placed was significantly correlated with the type of major connector fitted to the maxilla in patients in the overall sample ( $p=0.014$ )-Figure 2a and in the sub-group of men ( $p=0.032$ ) but not with women ( $p=0.126$ ). In the overall sample, most of the patients fitted with the Palatal Strap (88%), the Anterior-Posterior (83%), and the U-shaped connectors (86%) were either in Kennedy Class II (38%, 35%, and 29% respectively) or Class III (50%, 48%, and 57% respectively). On the other hand, many (86 %) of the patients fitted with the Palatal Plate connector were in Class I (53%) or Class II (33%). No Class I patient was fitted with a U-shaped connector. No Class IV patient was fitted with Palatal Strap or Palatal Plate connectors - Figure 2a. In the sub-group of men, patients fitted with the Palatal Strap or Palatal plate was in either of two Kennedy Classes: Class I (67%) or II (33 %) for the Plate and Class I (25%) or Class III (75%) for the Strap. No male patient in Class I was fitted with either a U-shaped

connector or any in Class IV with an Anterior-Posterior connector.

The Kennedy Class of the patient was significantly correlated with the type of major connector (Lingual Bar versus Lingual Plate) fitted to the mandible for patients in the overall sample ( $p=0.03$ ) but not when this is broken out into the sub-groups of women ( $p=0.057$ ) and men ( $p=0.195$ )-Figure 2b. Most (55%) of the patients fitted with a Lingual Plate are in Class I, while only 26% of those fitted with the Lingual Bar are in this class. Whether or not an indirect retainer is added to the major connector fitted to the maxilla or to the mandible is tested for correlation with different conditions- the number of missing teeth, the Kennedy Classification of the patient, and the type of major connector. For the maxilla, the addition of an indirect retainer is significant correlated ( $p=0.046$ ) to the number of missing teeth with patients in the overall sample (Figure 1c) but not in the sub-groups. It is significantly correlated too with the Kennedy Classification of the patient (for both the overall sample ( $p=0.001$ )-Figure 2c and for the sub-group of women ( $p=0.001$ ) but not for men) and with the type of major connector fitted to the maxilla but only for men ( $p=0.049$ ), not for women or the overall sample. The retainer is mostly added to patients with 6 to 10 missing teeth (61%) and not added when the patient only has 1 to 5 missing teeth (59%). It is added to the major maxilla connector for most of the patients in Kennedy Classes II (92%), I (95%), and IV (100%) but to only 57% of the patients in Class III. With the mandible, there is no significant correlation between the addition of an indirect retainer to the major connector and the number of missing teeth, or the Kennedy Classification, or the type of

major mandible connector to which the retainer is added.

To sum up the results this study found a difference between the patterns of tooth loss in the maxilla and in the mandible for this patient sample and women in the sample had lost more teeth in the maxilla than men but men tended to lose more teeth in the mandible, when compared to women. There was a significant relationship ( $p=0.000$ ) between the number of teeth lost and the type of major connector used in the mandible (for overall sample and for women) but no correlation with the maxilla major connector. The decision to incorporate an indirect retainer was significantly correlated with both the number of missing teeth and the Kennedy Classification in the maxilla ( $p=0.0460$ ) but not in the mandible. This is also true for the group collectively ( $p=0.000$ ). No significance was found between the use of indirect retainers added to major connectors in mandibular dentures with patients in the overall sample or in the women and men sub-groups. This is because indirect retainers were employed in almost all (97%) of these dentures. Additional 'I' bars with mesial rests (RPI system) and a double 'I' bar with mesial rests were found sometimes to be applicable in the Kennedy Class II and Class I situations respectively. These were cases where a canine and 1<sup>st</sup> premolar and/or two premolar teeth were used as the posterior abutments, either in the maxilla or mandible. Figure 3a and 3b shows top views of indirect retainers with double 'I' bars used in Cobalt-Chrome frames for the Maxillary and Mandibular dentures.

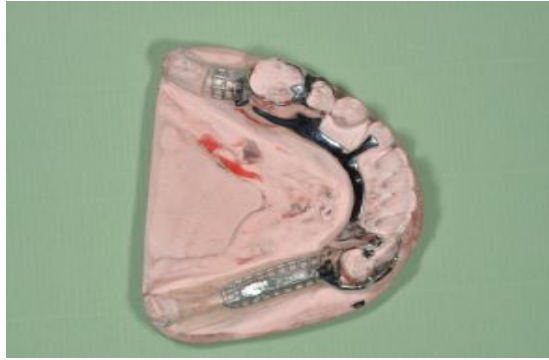


Fig.3a

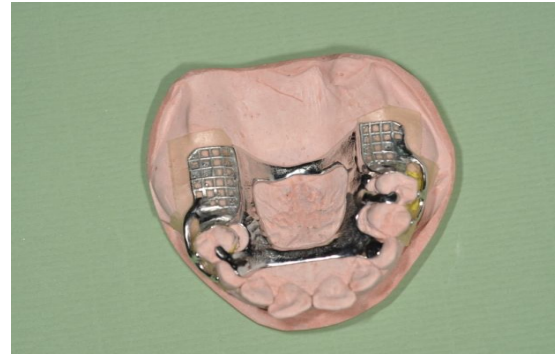


Fig.3b

**Table 1: Chi Square tests of Independence for pairs of dental characteristics in patients fitted with removable partial dentures**

| Variable 1   | Variable 2                      | Significance of $\chi^2$ Test | Trend  |
|--|---------------------------------|-------------------------------|--|
| <b>Number of Missing Teeth (in the associated dental arch)</b> | Mandible Kennedy Classification | S (p=0.000)- Overall Sample   | Patients with 1 to 5 missing teeth are predominantly in Classes II (47%) and III (31%) but those with 6 to 10 missing teeth are mostly in Classes I (49%) and II (42%)   |
|  |                                 | S (p=0.000)- Women            | Women in Classes II (71%), III (90%) and IV (100%) predominantly had 1 to 5 missing teeth. Those in Class I are distributed more evenly over the 3 categories of missing teeth, namely 1 to 5(32%), 6 to 10(46%), and > 10(22%). |
|  | Major Connector-Mandible        | S (p=0.000) – overall         | Lingual Bar: 1 to 5 missing teeth (70%).<br>Lingual Plate: 6 to 10 teeth (67%).  |
|  |                                 | S (p=0.000)- women            | Lingual Bar: 1 to 5(72%) or 6 to 10(22%) missing teeth.<br>Lingual Plate: 1 to 5(22%) or 6 to 10(56%) or >10 (22 %) missing teeth.   |
|  |                                 | S (p=0.011)- men              | Lingual Bar: 1 to 5 missing teeth (63%).<br>Lingual Plate: 6 to 10 missing teeth (90%).  |
|  | <b>Kennedy Classification</b>   | Major Connector-Maxilla       | S (p=0.014)- overall   |
| S (p=0.032) – men  |                                 |                               | Distributions of patients over the different Kennedy classes are significantly different for the   |

|   |                                  |                      |  |
|---|----------------------------------|----------------------|--|
|   |                                  |                      | different types of major maxilla connectors:<br>Palatal Plate: <b>Class I:</b> (67%) <sup>1</sup> , <b>Class II</b> (33%);<br>Palatal Strap: <b>Class I</b> (25%) <sup>1</sup> , <b>Class III</b> (75%) <sup>1</sup> ; U-shaped: <b>Class II</b> (17%) <sup>1</sup> , <b>Class III</b> (66%) <sup>1</sup> ; <b>Class IV</b> (17%) <sup>1</sup> ; Anterior Posterior: <b>Class I</b> (10%) <b>Class II</b> (55%) <sup>1</sup> , <b>Class III</b> (35%) <sup>1</sup> . |
|   | Major Connector – Mandible       | S (p=0.03) – overall | Lingual Bar: <b>Class I</b> (26%), <b>Class II</b> (40%), OR <b>Class III</b> (25%).<br>Lingual Plate: <b>Class I</b> (55%) OR <b>Class II</b> (36%).  |
| <b>Indirect Retainer added to Major Connector<sup>2</sup></b> | Missing Teeth- Maxilla           | S (p=0.046)- overall | Most (61%) of those given the retainer had 6 to 10 teeth missing.<br>Most (59%) of those not given the retainer had 1 to 5 missing teeth.  |
|   | Kennedy Classification – Maxilla | S (p=0.001)- overall | Given Retainer <sup>3</sup> : <b>Class I</b> (95%), <b>Class II</b> (92%), <b>Class III (59%)</b> and <b>Class IV</b> (100%).  |
|   |                                  | S (p=0.001) – women  | Given Retainer <sup>3</sup> : <b>Class I</b> (100%), <b>Class II</b> (95%), <b>Class III (57%)</b> and <b>Class IV</b> (100%).   |
|   |                                  | S (p=0.049) – men    | Given Retainer <sup>3</sup> : Palatal Strap (25%), Anterior-Posterior (80%), Palatal Plate (68%), and U-shaped (100%).   |

1. This refers to the percentage of the total number of patients fitted with a specific connector.
2. A double 'I' bar and indirect retainer (Figure 3) were used in Kennedy Class I cases where the patient had 1-5 missing teeth and in all Class II cases, either maxilla or mandible. This is especially true where there were canine and first premolar or two premolars bilaterally.
3. The percentages are given only for those receiving the retainer. The difference between these and 100% in each class would be the values for those not receiving the retainer in that class.

### Discussion

It is generally accepted that the design of dentures follows some form of partially edentulous classification. The classification used in this study is the Kennedy classification and this is principally based on the location of the missing teeth rather than the quantity. The results clearly show the lack of significance between the quantity of missing teeth in the maxilla and classification for the entire sample or for the men and women sub-groups individually. The only significant association in this study between the number of missing teeth of the patient and the Kennedy classification was found in the mandible for women alone. There is very little information published on any association of the actual number of missing

teeth and the Kennedy classification. This left unanswered the question of whether the number of missing teeth, in addition to the location of the edentulous ridge, should influence the design of the denture for any Kennedy Class designation of tooth loss. In this study, the number of missing teeth in the maxilla was not significantly correlated with the type of major connector used for either men or women but, with the mandible, that association was significant for both men and women.

The correlations between the types of major connector and the Kennedy classifications were significant for the overall sample in both the maxilla and the mandible but when broken out by sex, there was significant correlation (at  $\alpha = 0.05$ ) between the major connector and the



Kennedy classification for men but not women in the maxilla and for neither in the mandible, although the women showed a trend ( $p=0.057$ ). The results above suggest, but do not confirm, that in the mandible for women both the Kennedy classification and the number of missing teeth may influence the ultimate removable partial denture design chosen. This may be coincidental since, in some instances, studies found that the type of major connectors selected does not necessarily comply with the indications for their use.<sup>[1, 14]</sup> The influence of teaching philosophy and the diversity of faculty members' background have been suggested instead as a possible explanation of the variations of designs utilized.<sup>[5]</sup> Others suggest that biomechanical and hygiene factors have an influence on the variations of designs employed.<sup>[3]</sup>

The use of indirect retainers reduces the movement of the denture around a fulcrum. It may also reduce the stresses on the distal abutment teeth in Kennedy classes I and II.<sup>[15]</sup> In these situations, where there is either a single or bilateral distal edentulous ridge, there exists the possibility of rotation about a fulcrum that passes along these distal abutments. To prevent the movement of the denture away from the edentulous ridge the metal is extended onto teeth anterior to this fulcrum, ideally onto the canines. In Class III situations there is no true fulcrum and the indirect retainer is not typically employed.

In this study, there were significant associations between the use of the indirect retainers and (i) the number of missing teeth (overall sample), (ii) the Kennedy Classification of the tooth loss pattern (women in the mandible only) and (iii) the major connector used (men in the maxilla only). The indirect retainer was found applicable in Class III situations, especially in

cases where there was a larger amount of teeth missing. In Class III situations, the posterior teeth used as the distal abutments are usually molars. These are the largest teeth and are often tilted because of the absence of adjacent teeth and other factors. This means that the retentive clasp is longer, and because of a possible tilt, produces unfavorable survey lines. Under these presenting conditions, the use of indirect retainers assists these retentive clasps on the distal abutments.

Finally, in situations where there are one or two free end edentulous alveolar ridges, there is always rotation around a fulcrum line. There is higher strain and displacements in the bone tissue below the denture.<sup>[16]</sup> The soft tissues are displaced as the dentures rotate around this fulcrum line. A standard technique taught universally to reduce this rotation is called the altered cast technique. After the frame is fabricated, another impression is made of the edentulous area under controlled pressure. This is felt to create a denture base that fits under conditions that mimic functional loading.<sup>[17]</sup> Some studies found that the use of this technique does not offer any significant advantage.<sup>[18]</sup> Either way, at all times the objective of denture design is the incorporation of components which would produce, ultimately, a more stable appliance. In this study for all Class I and Class II cases presenting with premolars and canines, a double 'I' bar with mesial rest plus indirect retainers were incorporated into the frame (Figure 3). The use of the double RPI (mesial rest, guide plane and 'I' bar) effectively removes the fulcrum effect by changing the configuration to a significantly more stable trapezoid support.

There is still a demand for removable partial dentures. The practitioner is usually faced with the

challenge of replacing several missing teeth and rehabilitating the patient with appliances that would be the least destructive to the remaining oral structures, among other requirements. Careful survey of a diagnostic cast will identify abutment teeth that are tilted or somehow have unfavorable survey lines. Adding components, for example the double 'I' bar and rest, will reduce the torque on less-than-ideal direct retainers in Kennedy Class III situations and remove the fulcrum in Class I and II situations. The cast dentures fabricated at the dental school, regardless of the training of the prosthodontist, are based on the demands of biomechanical stability, hygiene, and preservation of the remaining oral structures.

Clear associations could be seen in many cases, even those that were not statistically significant because of underpopulated categories, between the removable partial denture, with or without an additional indirect retainer, and the pattern of tooth loss in each jaw. Going forward, additional data, in particular patient feedback about satisfaction with fit and construction (comfort, aesthetics, and durability) will be collected for many more patients with a view to standardizing the type of major connector used for different scenarios or characteristics of sex, Kennedy Classification, and number of missing teeth.

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