

A Survey of Removable Partial Denture Casts and Major Connector Designs Found in Commercial Laboratories, Athens, Greece

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Keywords

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Abstract

Purpose: This survey was conducted to study the prevalence of partial edentulism, the type of removable partial denture (RPD) support, the type of major connectors, and the frequency of their use in relation to the partial edentulism classes encountered, concerning patients in Athens, Greece.

Materials and Methods: The material comprised 628 final casts for RPDs. Each cast was photographed in a way that would allow the number of existing teeth, the classification of partial edentulism, the RPD support, and the particular parts of the metal framework to be identified. Data collected were analyzed statistically using prevalence tables and the χ^2 test.

Results: Two hundred seventy six (43.9%) casts were for the maxilla and 352 (56.1%) for the mandible. The most frequently encountered group was Kennedy class I for both arches, while class IV was the classification least encountered (p < 0.001). Of all RPDs constructed, 96.8% had a metal framework (tooth-borne and tooth/tissue-borne), while 3.2% of the RPDs were frameless (tissue-borne, acrylic dentures). The U-shaped palatal connector (horseshoe) in the maxilla and the lingual bar in the mandible were the most frequently used for all partial edentulism classes, at 55.2% and 95%, respectively. **Conclusions:** Analysis of the casts revealed that the type of major connectors selected does not comply with the indications for their applications, considering the lack of dental history and clinical examination. This notes the need for further training dentists and dental technicians in aspects of RPD framework design.

Partial edentulism of the dental arches is represented clinically by the presence of edentulous areas within the dentition. Although the term partial edentulism is not literally correct, it has prevailed in daily clinical practice to indicate any absence of teeth from dental arches. The various combinations of partial edentulism for each arch (around 65,000),¹ the type of removable prostheses for their restoration, and the need for dentists and dental technicians to communicate effectively have led to various classification systems.¹⁻¹²

Kennedy's method of classification,² which describes four types of partial edentulism (I: bilateral edentulous areas behind existing natural teeth; II: unilateral edentulous area behind existing natural teeth; III: unilateral edentulous area with the last molar present; IV: anterior edentulous area in front of existing natural teeth), combined with the subgroups introduced by Applegate's modifications¹³ (edentulous areas, additional to those defining the group and characterized by the total number of such areas, i.e., substitute modification spaces for subgroup 1, 2, 3, 4...), is considered to be the most widely accepted classification. This is so because it refers not only to the relationship of the edentulous area with the remaining natural teeth, but it also determines the type of removable partial denture (RPD) design to be used.¹⁴ Classic textbooks¹⁴⁻¹⁷ on RPDs describe several types of major connectors; however, few of them are used in daily practice according to specific indications related to the classes of partial edentulism.

Regarding maxillary major connectors, the palatal strap is mainly indicated in Kennedy class III cases, whereas the anterior-posterior palatal strap is mainly used in Kennedy class I and II, in cases of central *tori palatinus* and when other major connector types are not well tolerated. The U-shaped palatal connector (horseshoe) is mainly used in cases of short edentulous areas and when *tori palatinus* (located centrally and/or posteriorly) are present. The palatal plate is designed for cases of extensive edentulous areas in Kennedy classes I and II, and when the abutment support is poor.¹⁴

As for mandibular major connectors, a lingual bar is indicated, regardless of partial edentulism class and extent, when there is sufficient space between the floor of the mouth and the free gingival margins. A sublingual bar is recommended in cases of insufficient space between the floor of the mouth and the free gingival margins and intolerance to the lingual bar. A lingual plate is used in cases of a shallow mouth floor, in Kennedy class I, with extensive alveolar crest resorption and in cases where a partial denture is to be repaired with additional teeth. A mandibular continuous bar (cingulum bar or Karlsen) is applied in cases of insufficient space between the floor of the mouth and the free gingival margins, when there are *tori mandibularis*, and when abutment teeth provide limited osseous support.¹⁴

It is well known that epidemiological surveys recording the class of partial edentulism, the type of RPDs, and the metal framework design are considered to promote higher quality dental-prosthetic care services.¹⁸⁻²⁰ The purpose of this survey was to study the prevalence of partial edentulism, the type of RPD support, the type of major connectors, and the frequency of their use in relation to the partial edentulism classes encountered.

Materials and methods

For the purposes of this survey, three commercial laboratories were randomly chosen, via simple random sampling, out of a total of 10 certificated commercial dental laboratories employing more than 15 employees, based on their cooperation with dentists who provide their services to patients in the Athens, Greece area. The material comprised 628 working casts for partial dentures collected for a period of 6 months on a daily basis. Each cast was photographed by the same author, using a digital camera (Canon Digital Ixus 750, Canon UK, Surrey, UK) in a way that would allow the number of existing teeth, the class of partial edentulism, the RPD support, and the particular parts of the metal framework to be identified. The photographs of each case were examined on a PC monitor and aspects investigated were recorded in a special form. Features were recognized and classified by all three authors in cooperation. In almost all cases (98%) there was agreement among readers. In the cases of disagreement, the reading in which two authors agreed was recorded. For recording each class of partial edentulism and type of major connector, the terminology of the 8th edition of the Glossary of Prosthodontic Terms21 and the description provided in classic textbooks^{14,15,17} were used.

Classification of partial edentulism

Classification was recorded in accordance with Kennedy classes and Applegate's rules. Fixed prosthetic restorations were recorded as existing teeth.

Types of RPD support:

 Tooth-borne RPD: Support provided only by teeth (restoration of edentulism in Kennedy classes III and IV²²).

- 2. Tooth/Tissue-borne RPD: Support provided by both teeth and mucosa (restoration of edentulism in Kennedy classes I, II, and IV with extensive edentulous space²²).
- 3. Tissue-borne RPD: RPD without metal framework (acrylic dentures).

Types of major connector

Major connectors were distinguished and classified in accordance with the specifications presented below:

- 1. Palatal strap (PS): providing transverse palatal cover, normally 10 mm in width, and up to 20 mm in extreme cases.
- 2. Anterior-posterior palatal strap (A-PPS): comprising two transverse palatal straps (8 to 10 mm) and two sagittal parallel straps, around 6 mm in width.
- 3. U-shaped palatal connector (U-SPC): covering the anterior third of the palate with a minimum width of 10 mm.
- 4. Palatal plate (PP): covering the largest part of the palate.
- 5. Lingual bar (LB): 4 mm in height.
- 6. Lingual plate (LP): modified lingual bar extending on the lingual aspect of anterior teeth.
- 7. Mandibular continuous bar (MCB): covering the lingual aspect of anterior teeth between their cutting edge and the cingula.
- 8. Sublingual bar (SLB): applied in the lingual-gingival groove in the region of anterior mandibular teeth.
- 9. Other: not included in the types of major connectors described above.

Data collected were analyzed statistically using prevalence tables and the χ^2 test. All statistical analyses were based on the SPSS statistical program and calculated at a (p = 0.05) significance level.

Results

A total of 628 casts used for making RPDs were photographed. Maxillary and mandibular casts represented 43.9% and 56.1% of the sample, respectively (Fig 1).

Kennedy class I, in both arches, was the most frequently type found (Table 1), while class IV was the least frequent, and this was statistically significant (p < 0.001). For both jaws, subgroup 1 (one additional edentulous space) represented the majority of cases, while subgroup 3 (three additional edentulous spaces) represented a mere 2.6% of all cases (Table 2). No statistically significant differences were observed in each subgroup in relation to the arches involved (p = 0.21) or the class of edentulism (p = 0.08) (Tables 2, 3).

A total of 608 (96.8%) RPDs with a metal framework (toothborne and tooth/tissue-borne) and 20 (3.2%) without a metal framework (tissue-borne) were recorded. Regarding the type of major connector and for all classes of edentulism, the Ushaped connector was the most frequently used for the maxilla and the lingual bar for the mandible, 55.2% and 95%, respectively (Figs 2, 3). The relationship between the major connector and the class of edentulism was not found to be statistically significant (p = 0.09 for the maxilla; p = 0.07 for the mandible) (Tables 4, 5).



Figure 1 Distribution of maxillary and mandibular casts.

Table 1 Kennedy classes per arch

	Maxilla		Μ	andible	Total	
Class	n	%	n	%	n	%
	120	43.5%	228	64.8%	348	55.4%
11	111	40.2%	95	27.0%	206	32.8%
111	37	13.4%	26	7.4%	63	10.0%
IV	8	2.9%	3	0.9%	11	1.8%
Total	276	100.0%	352	100.0%	628	1000%

Chi-square test 30.2; *p* < 0.001.

Table 2 Subgroups in all Kennedy classes

	Maxilla		M	andible	Total	
Subgroup	n	%	n	%	n	%
1	101	71.6%	137	80.1%	238	76.3%
2	36	25.5%	30	17 . 5%	66	21.2%
3	4	2.8%	4	2.3%	8	2.6%
Total	141	100.0%	171	100.0%	312	100.0%

Chi-square test 3.1; p = 0.21.

Table 3 Subgroups per Kennedy class

	C	Class I		Class II		Class III		Total	
Subgroup	n	%	n	%	n	%	n	%	
1	96	82.1%	101	69.2%	41	83.7%	238	76.3%	
2	20	17.1%	39	26.7%	7	14.3%	66	21.2%	
3	1	0.9%	6	4.1%	1	2.0%	8	2.6%	
Total	117	100.0%	146	100.0%	49	100.0%	312	100.0%	

Chi-square test 8.7; p = 0.08.

Discussion

Indisputably, as confirmed by epidemiological evidence available, the need to construct an RPD in a way that not only restores the mouth but also minimizes potential damage to the supporting tissues is considered to be a viable and low cost clinical modality.²² Although there is a tendency to provide fixed prosthodontic treatment to patients, this might change because of low socioeconomic status in large parts of the world and demographic changes.²³ Clinical examination,²⁰ completing instruction forms,²⁴ and photographic records¹⁸ have been used in epidemiological and clinical studies for recording the classes of partial edentulism, the type of RPD support, and the design of the type of metal framework. In this study, we used photographic records of casts, because this method allows the data to be analyzed outside the laboratory at any given time by all authors. The selection of three major dental laboratories, based on their cooperation with dentists who provide their services to patients in different parts of Athens, was made so as to collect data that reflect a representative cross-section of patients in need of prosthetic treatment with RPDs.

Distribution of RPDs

Our finding that maxillary casts are less prevalent than mandibular ones (43.9% and 56.1%, respectively) is similar to what was reported by Öwall and Taylor¹⁸ for North America in 1989: of the 1374 casts photographed, 558 (40.65%) concerned the maxilla and 816 (59.4%) the mandible. In another paper, Öwall et al,¹⁹ for western Germany in 1995, examined 1082 photographs of an equal number of casts for RPDs, of which 511 (47.2%) concerned the maxilla and 571 (52.8%) the mandible. Curtis et al,²⁵ for Northern California in 1992, evaluating data collected by filling out printed instructions concerning 327 metal frameworks, found that maxillary casts represented 37.3%, while mandibular ones, 62.7%.

Our results contradict those by Basker et al,²⁶ whose study was undertaken in the United Kingdom in 1988, where 330 RPD frameworks were studied using photographs, 209 (63.3%) concerned the maxilla and 121 (36.7%) the mandible. Furthermore, Öwall et al,²⁷ for Scotland in 1996, reported that of the 539 photographs examined, the distribution of maxillary and mandibular RPDs was 70.4% and 29.6%, respectively. Similarly, a higher percentage of maxillary casts was also found by AL-Dwairi²⁴ for Jordan, in 2006 where of the 350 printed instructions filled out by dental technicians, 193 (55.14%) concerned the maxilla and 157 (44.86%) the mandible. These indicative studies do not allow any clear conclusions to be drawn as to whether the percentage of maxillary RPDs is higher than that of mandibular ones or vice versa.

Classification of partial edentulism

Kennedy class I was found with the highest frequency (55.4%) compared to the other classifications in both jaws (43.5%) in the maxilla, 64.8% in the mandible), in contrast to the report





Figure 3 Type and distribution of mandibular major connectors (LB: lingual bar, LP: lingual plate, SLB: sublingual bar, MCB: mandibular continuous bar, other: not clearly included in the aforementioned types of major connectors).

 Table 4
 Maxillary major connectors per Kennedy class

	Class I %	Class II %	Classes III and IV* %	Total %
U-SPC	55.5%	57.4%	48.8%	55.2%
PP	16.8%	7.4%	4.7%	11.1%
PS	15.1%	25.9%	34.9%	22.6%
A-PPS	2.5%	1.9%	2.3%	2.2%
Other	10.1%	7.4%	9.3%	8.9%
Total	100.0%	100.0%	100.0%	100.0%

*Classes III and IV were grouped together due to the small sample size. Chi-square test 13.8; p = 0.09.

by Basker et al,²⁶ for the United Kingdom in 1988, and by AL-Dwairi²⁴ for Jordan in 2006, who reported Kennedy class III as the most frequent.

Type of RPD support

Of the RPDs, 96.8% were metal framework and only 3.2% were frameless RPDs (acrylic dentures). This frequency is similar to that reported by Öwall et al¹⁹ (<4%) in a study undertaken in western Germany in 1995. On the contrary, other studies report rather higher percentage rates: Toremalm and Öwall,²⁸ 35% (Sweden, 1988); Lewandowska et al,²⁹ 85.4% (Poland, 1989); Öwall and Taylor,¹⁸ 10% (North America, 1989); Öwall et al,²⁷ 33.6% (Scotland, 1996); and Fejérdy et al,²⁰ 50% (Hungary, 2008). A possible explanation for the above-mentioned per-

Table 5 Mandibular major connectors per Kennedy class

	Class I %	Class II %	Classes III and IV* %	Total %
LB	96.4%	90.9%	96.3%	95.0%
LP	3.1%	2.3%		2.7%
SLB		2.3%		0.6%
MCB		1.1%		0.3%
Other	0.4%	3.4%	3.7%	1.5%
Total	100.0%	100.0%	100.0%	100.0%

*Classes III and IV were grouped together due to the small sample size. Chi-square test 14.4; p = 0.07.

centage rates may reflect the domestic teaching approach (e.g., frameless RPDs as transitional prostheses), different kinds of prosthodontic therapy, and financial reasons.

Type of major connector

The finding that the frequency of U-shaped palatal connector (horseshoe) (55.2%) is higher when compared to the rest of major maxillary connectors is compatible with the report (56%) by Öwall and Taylor¹⁸ (North America, 1989). Contradicting this finding, some studies reported the palatal strap as the most commonly used connector, at the following percentage rates: 70.5% Curtis et al²⁵ (Northern California, 1992), 53% Öwall et al¹⁹ (western Germany, 1995), and 37.8% AL-Dwairi²⁴ (Jordan, 2006).

The most commonly used connector in the mandible was the lingual bar, at a percentage of 95%. This was similar to the results reported by Basker et al^{26} (56%, UK, 1988), Öwall and Taylor¹⁸ (66%, North America, 1989), Curtis et al^{25} (72.9%, Northern California, 1992), Öwall et al^{19} (84.8%, western Germany, 1995), and AL-Dwairi²⁴ (77%, Jordan, 2006).

Although there are specific design indications for every type of major connector, this guideline is often neglected in daily clinical practice, as one or two types of connectors seem to be preferred for any class of partial edentulism. A typical example is that of a Kennedy class I and extensive maxillary edentulous areas: although a palatal plate is indicated, our results show that the U-shaped palatal connector (considered the least favorable design)^{14,17,30} is the most frequently used. This might mean that dental technicians are more familiar with the construction of this major connector. Another reason might be that dentists have to accept their patients' desire for minimal palatal coverage by the metal framework.

The almost exclusive use of the lingual bar in lower RPDs, in addition to the fact that it provides the most cleansibility for a patient requiring an RPD, furthermore indicates the ease and familiarization of dental technicians with the construction of this simple connector. Finally, we must point out that students are thoroughly educated in dental school and taught in great detail on the subject of RPDs; yet, when they work as practitioners, it seems that they leave the RPD design to dental technicians.

Conclusions

Under the limitations of this study the following conclusions can be drawn:

- 1. The most frequently encountered partial edentulism is Kennedy class I, presenting higher prevalence in the mandible than the maxilla.
- The most commonly used major connectors are the Ushaped palatal connector in the maxilla, presenting a statistically significant difference, and the lingual bar in the mandible, which is almost exclusively preferred.
- 3. The overwhelming majority of RPDs are of tooth-tissue support with a metal framework.
- 4. The major connector selected does not comply with the indications for its applications, considering the lack of dental history and clinical examination.

We consider that further emphasis should be put on aspects of RPD design in dentists and dental technicians, in turn contributing to higher quality of prosthodontic treatment.

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