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Longitudinal Clinical Evaluation of Undercut Areas and Rest Seats of Abutment Teeth in Removable Partial Denture Treatment

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Abstract

Purpose: Adequate preparation of abutment teeth for removable partial denture (RPD) rest seats allows appropriate masticatory force transmission, retention, and stability of supporting structures. It follows that careful preparation will be important for the longevity of the rehabilitation. The present study aimed to clinically evaluate rest seats and undercut areas of abutment teeth in RPD wearers after 2 years of use.
Materials and Methods: A total of 193 occlusal, incisal, and cingulum rest seats were evaluated in terms of shape, rest adaptation, wear, caries, fractures, and surface type (enamel, composite resin, or amalgam). Two hundred and fourteen undercut areas were evaluated in terms of surface type (enamel or restoration) and integrity. This study was approved by the Research Ethics Committee of the Federal University of Rio Grande do Norte, resolution 196/1996, protocol number 11/05.
Results: Intact preparations accounted for 92.2% of the total. Application of the Pearson test ($p = 0.289$) found no statistically significant differences among the materials on which the rest seats were prepared. For the undercut areas, 20.7% of those obtained on restorative material were nonintact. In addition, Fisher's exact test showed a statistically significant difference ($p = 0.001$) in surface type; enamel surfaces were shown to be 14 times more stable than restored surfaces.
Conclusions: The results of this study suggest that rest seats are stable, regardless of the material on which they are prepared. Retentive areas were shown to be more stable when they were located in enamel.

Removable partial dentures (RPD) are commonly used in the rehabilitation of edentulous areas, to allow for the implementation of conservative principles, and to provide a fast and cost-effective treatment. Gomes and Renner[1] suggested that the most important factors in the fabrication of RPDs are the selection, distribution, and location of the abutment teeth. After abutment selection, the next step is to evaluate the periodontal status of the tooth as well as its crown and root status.[2] Diagnosis and planning are established after a thorough clinical examination associated with articulator-mounted casts and a dental surveyor to guide abutment preparations.

The RPD is a mechanical structure associated with biological structures in an oral environment. From a biomechanical standpoint, the success or failure of this structure will depend on the design and fabrication of the metallic framework. Planning and design should provide simplicity, comfort, occlusal stability, good oral hygiene, and acceptable esthetics. All these factors are important in preserving the remaining structures, which is the primary goal of rehabilitation.[3]

No rigid scientific criteria have been established for the design of RPDs. Many different framework designs may be appropriately used for a particular case. According to Owall,[4] planning principles should be based on an individual evaluation of each case.

Preparation of the oral environment is fundamental to a successful removable RPD.[5,6] This process includes several procedures to improve oral conditions in preparation for insertion of the RPD. This step is often neglected, resulting in further damage, instead of oral health restoration.[7]

Specific steps for RPD therapy include preparation of rest seats, guide planes, undercut areas, and survey line adequacy. A rest seat is defined as the concavity prepared on the surface of an abutment tooth on which the rests are to be lodged. Its purpose is to accept the cast rest portion of an RPD framework so as to direct masticatory forces in a specified manner.[5] Planning for these preparations is important to ensure correct transmission of masticatory forces along the long axis of the abutments and to avoid the occurrence of lateral forces on the periodontium.

The term undercut refers to the contour or cross section of a residual ridge or dental arch that would prevent placement of a denture.[5] Undercut areas should be quantified to establish the exact location of the active tip of the retentive arms. This procedure is important for obtaining appropriate prosthesis retention during gingival-occlusal movement and effective reciprocity of the reciprocal clasp. When natural retention is absent, it can be obtained with crown restorations, as in the subjects for this study,[5,8] class V restorations in amalgam,[9] enamel recontouring,[10] or recontouring with resin.[3,11-13]

Longitudinal studies for the evaluation of RPD planning and follow-up after prosthesis insertion are needed to assess the effectiveness of techniques for the preservation of remaining structures and the conservation of the preparations for prosthesis insertion. The aim of this study was to clinically evaluate the rest seats and undercut areas in RPD wearers 2 years after insertion. The integrity of occlusal, incisal, and cingulum rest seats was evaluated as to preparations in enamel, composite resin, or amalgam. Continued retention of the undercut areas was assessed on surface type, in enamel or restorative material.

Materials and methods

This study comprised a prospective cohort of 30 individuals who were enrolled in a clinical assay conducted by the Department of Dentistry of the Federal University of Rio Grande do Norte (UFRN) with 24 month follow-up. The sample was intentional and included patients requiring oral rehabilitation and receiving an RPD from the Removable Partial Denture and General Dentistry disciplines of the Department of Dentistry at UFRN in 2005. All patients had received previous oral treatment and specific oral preparation for each case, including well-defined rest seats for support location, space for the clasp arm to permit passage through the undercut area, etc. A delineator was used for planning.

The sample was initially composed of 50 patients, who were followed up every 3 months in the first year, to analyze the periodontal condition of the abutment and nonabutment elements of the RPDs. The resulting report was accepted for publication in 2010. Losses occurred in the initial sample due to the prolonged 2 year long follow-up, leaving a reduced sample of 30 patients. The research was approved by the Ethics Committee on Research UFRN, resolution 196/1996-CNS, Protocol 11/05.

In addition to periodontal assessment, RPDs were clinically examined in an analysis of rest seats and undercut areas. Data collection was carried out by an experienced dental prosthetics specialist and recorded by a second person. Data were gathered in a thorough clinical examination using a no. 5 dental mirror, dental tweezers, and Williams periodontal probe (Trinity® periodontics—Jaraguá, Brazil). In addition to clinical examination, alginate molds were made to analyze the models in a delineator and verify the presence of retentive areas.

A total of 193 occlusal, incisal, and cingulum rests seats were evaluated in terms of shape, rest adaptation, wear, caries, fracture, and surface type (enamel, composite resin, or amalgam),

Table 1 Analysis of the sample according to the aspect and surface type of the rest

	Rest seat surface aspect						
	Intact		Nonintact		Total		
Surface type	n	%	n	%	n	%	p^*
Enamel	54	96.4	2	3.6	56	100	0.289
Resin	50	92.6	4	7.4	54	100	
Amalgam	74	82.9	9	10.8	83	100	
Total	178	92.2	15	7.8	193	100	

*Chi-squared test.

Table 2 Analysis of the sample according to the aspect and surface type of the undercut area

	Aspect of the undercut area								
	Intact		Nonintact		Total				
Surface type	n	%	n	%	n	%	p^*	OR	CI 95%
Enamel	110	98.2	2	1.8	112	100	0.001	14.38	2.7–75.6
Restorative material	23	79.3	6	20.7	29	100			
Total	133	94.3	8	5.7	141	100			

*Fischer's exact test.

as prepared in the previous study. A total of 141 undercut areas were also assessed in terms of the surface type on which they were positioned (enamel or restoration).

These data were then divided into intact and nonintact, according to the type of surface on which it was prepared. Statistical analysis was carried out using SPSS (version 17.0; SPSS Inc., Chicago, IL) software. The undercut areas were evaluated using Fischer's exact test and the rest seats using the chi-squared test.

Results

Table 1 exhibits the data related to the aspect and surface type of the rest, classified according to the presence or absence of rest seat integrity. Amalgam demonstrated the highest percentage of nonintact rest seat preparations (10.8%).

No statistically significant differences were found between the materials on which the rest seats were prepared and surface integrity ($p = 0.289$). Table 2 shows the results obtained for the undercut area on which the clasps were positioned. A total of 20.7% of the undercut areas obtained on restorative material (composite resin or amalgam) were nonintact, that is, these surfaces had lost retention 2 years after prosthesis insertion. As a result, there was a statistically significant difference ($p = 0.001$) among surface types on which the undercut areas were obtained, with enamel surfaces found to be 14 times more stable than restored surfaces (OR = 14.38).

Discussion

The prospective cohort study described in this report clinically assessed the rest seats and undercut areas of RPD wearers after

2 years of use. Rest seats considered to be intact accounted for 92.2% of the total, and no statistically significant differences were found among the materials on which the rest seats were prepared; however, 20.7% of the undercut areas were classified as nonintact. Loss of retention occurred after 2 years of use, and a statistically significant difference ($p = 0.001$) was recorded with respect to the type of surface on which the undercut areas were located.

The rest seat can be prepared in enamel, resin restorations, amalgam, or the metal of the prosthetic restoration waxed during the laboratory phase. Preparations on direct restorations require sufficient depth and width to avoid exposing the dentin or exceeding the restorative material and the restoration lining.[6]

The RPD must have sufficient supporting ability for proper occlusal rehabilitation. Poor fit, inadequate size and shape of the occlusal rest, and improper location of the rest seat may result in poor support.[14]

Little research has been reported on the integrity of both rest seats and undercut areas in different surface types. Moreover, there is no methodological standardization, hindering comparisons.

Sato et al[15] evaluated the resistance to fracture of rests with different levels of thickness and determined that the thicker the rest, the greater the resistance to fracture. Clinically, rest seat preparation should exhibit appropriate shape and depth, with rounded angles between the rest seat and the axial wall to provide a thicker metallic framework in this area. Resistance depends on both thickness and design and is related to the shape of the rest seat, since depth and shape allow for the mechanical function of the rest.

Lopes et al[16] compared the enamel shear bond strength of rest seats made with a glass ionomer cement, a resin-modified glass ionomer cement, or a composite resin. The rest seats were prepared on the lingual surfaces of 80 intact mandibular incisors. No statistically significant differences were found among the different materials used to manufacture the lingual rests.

The results of the present study corroborate those of Lopes et al[16] and Sato et al[15] These findings suggest that the type of surface on which the rest seats were made does not have a significant influence on the success of RPDs. On the other hand, in agreement with Sato et al,[15] rest seat preparation, obeying the principles of shape, depth, and width may be an important and decisive factor for their integrity, given that all of our niches were manufactured respecting these principles. This information is relevant for anterior abutments with an inclined palatal surface. For these abutments, the rest seat should be prepared on composite resin to allow axial direction of masticatory forces. Furthermore, preparation on enamel is not recommended since it is thinner in this region.

Indeed, Zanetti et al[17] evaluated 20 rest seats in intact maxillary canines prepared by the dental prosthetics faculty. The authors found dentin exposure in 30% of the preparations and inadequate depth in 85% of the rest seats.

Maeda et al[18] examined the longitudinal influence of bonded composite resin cingulum rest seats on abutment tooth periodontal tissues in RPDs. They suggested that bonded composite resin cingulum rest seats can be used longitudinally without damaging the periodontal tissues of abutment teeth. Twenty-eight patients with RPDs participated in the study. Thirty-one cingulum rest seats were prepared for an anterior tooth using composite resin and a standardized method for each patient. Clinical examinations were performed immediately after prosthesis insertion and at 3 month follow-ups over an 8 year period. None of the bonded resin rest seats failed; however, slight abrasion was observed in three rest seats.

According to Alarcon et al,[19] composite resins offer excellent esthetics, the ability to bond to tooth structure, and low thermal conductivity. They contain inorganic filler particles dispersed throughout a resin matrix, which contributes to these properties.

Sato et al[20] conducted a study using a 3D geometric analysis to assess the effects of buccolingual width and the location of occlusal rest seats on load transmission to the abutments for tooth-supported RPDs. Based on analysis of the tooth-supported RPDs, buccal shifting of the rest seats appears to be advantageous for load transmission to the abutments.

Similarly, Janus et al[21] observed no resin fracture or clinical signs of wear in cingulum rest seats prepared on resin in 26 patients. The authors found the use of cingulum rest seats prepared on resin to support the RPD to be a highly successful treatment option.

Vanzeveren et al[22] assessed the oral rehabilitation achieved by RPDs over periods ranging from 4 to 17 years after denture fitting. No change was observed for 92.2% of the maxillary abutments and for 85.8% of the mandibular abutments; whereas 3.1% of the abutments displayed new or recurrent caries, 4.4% of the abutments displayed a new restoration, and one crown had been renewed. The authors concluded that prosthetic restorations by RPD are not responsible for an increase in the rate of caries.

Clasp arms placed in undercut areas prevent prosthesis movement in the gingival-occlusal direction. As a result, the path of insertion and removal established should provide proportional undercut areas for all abutment teeth. It should also allow the retentive clasp equal or less action than the occlusal-gingival width of the guiding planes planned for the abutments.[6]

When the undercut areas are not identified, dental recontouring by increment or degree is recommended. These areas should be accurately identified in the cast. Several methods have been proposed for obtaining undercut areas, such as full-coverage crown fabrication and class V restorations with amalgam or resin; however, the full-coverage crown requires a specific recommendation, since it is an invasive treatment. The increased retentive surface area, caused by wear of tooth structure, should be recommended only when there is a need for minimum wear to obtain a retentive area. This is because enamel thickness in the cervical third of the crown surface is reduced, posing the risk of dentin exposure and requiring restoration.[13] According to Shimizu and Takahashi,[3] the safest and most conservative option is resin addition.

An in vitro study conducted by Davenport et al[22] assessed the resistance to abrasion of composite resins employed to provide a retentive area in RPD abutments. No significant loss of retention was found with the use of the prosthesis.

Despite the small sample, the present study found substantial loss of integrity in the undercut areas obtained on amalgam or composite resin. This result may be explained by the abrasion of restored surfaces due to the action of the retentive clasps of the RPD against the enamel surface. As a result, it is suggested that a maximum undercut area on the enamel surface is the best alternative for ensuring durability of RPDs.

Further studies are needed to confirm these results, given the patient loss during the 2 year follow-ups. We were unable to determine which of the restorative materials exhibited the best performance in the manufacture of retentive areas, or to establish which type of defect occurred most often in the different types of rest seat surfaces.

Conclusion

The present study suggests that 2 years after the manufacture and use of RPDs, the rest seats appear to be stable and intact, regardless of the material on which they were prepared; however, the undercut areas exhibited greater loss of integrity when located on restored surfaces and thus, seem to be more stable when located on enamel.

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