Revista Odonto Ciência

Journal of Dental Science

ORIGINAL ARTICLE

Rev Odonto Cienc 2013; 28(1)

http://revistaseletronicas.pucrs.br/ojs/index.php/fo

Open Access

Evaluation of occlusal rest seat depth in bicuspids: an experimental study

José Carlos Reis Campos[a], André Correia[a], Maria Helena Figueiral[a], Patrícia Fonseca[a], Filomena Rodrigues[b], Fernando Morais Branco[a]

[a] Removable Prosthodontics Department. Faculty of Dental Medicine of the University of Porto, Porto, Portugal

[b] Private Practice, Porto, Portugal

Abstract

Objective: Since premolars may be used as abutment teeth of removable partial dentures, the aim of this study was to evaluate the depth of occlusal rest seats in premolars and its relation with dentin and enamel.

Methods: Twenty-nine premolar teeth (extracted for orthodontic reasons) were randomly selected from patients at a University Clinic. The mesio-distal and buccal-lingual dimensions were measured. Rest seats were prepared with round burs (1.0-1.5 mm) in premolar mesial and distal fossae. Rest seats were cut with a microtome and observed in a scanning electron microscope. Tooth abrasion was also evaluated using the Gourdon indice.

Results: Significant differences were observed in the enamel thickness before and after rest seat preparations. Maximum enamel thickness in the deepest part of the rest seat was 625 μm in distal and 500 μm in mesial. In more than 50% of the teeth, dentin was reached. Almost 80% were not abraded.

Conclusion: In most situations it is not possible to prepare a rest seat with 1.5 mm depth only in enamel. In teeth not abraded it is possible to prepare rest seats with 1.0 mm without reaching dentin. There are significant differences between enamel thickness in distal and mesial, before and after rest seat preparation.

Keywords: Removable partial denture; dental abutments; bicuspid; dental enamel; dentin

Avaliação da profundidade de nichos oclusais em pré-molares: um estudo experimental

Resumo

Objetivo: Uma vez que os pré-molares são dentes normalmente utilizados como pilares de próteses parcias removíveis tipo Classe I e II de Kennedy, definiu-se como objectivo deste trabalho estudar a profundidade dos seus nichos oclusais e verificar a sua relação com dentina e esmalte.

Métodos: Seleccionaram-se de forma aleatória 29 dentes pré-molares (extraídos por motivos ortodônticos) em pacientes de uma Clínica Universitária. Mediram-se as dimensões mésio-distal e vestibulo-lingual. Os nichos oclusais foram preparados com brocas esféricas (1,0 mm-1,5 mm) nas fossas mesiais e distais, cortados com micrótomo e observados num microscópio de varrimento. A abrasão dentária foi avaliada com o índice de Gourdon.

Resultados: Observaram-se diferenças estatísticamente significativas na espessura do esmalte antes e depois da preparação dos nichos. A espessura máxima do esmalte no nicho oclusal distal foi 625 μm e 500 μm em mesial. Em mais de 50% dos dentes foi atingida a dentina. Quase 80% dos dentes não estavam abrasionados.

Conclusão: Na maioria das situações não é possível preparar nichos com 1,5 mm de profundidade somente no esmalte. Em dentes não abrasionados é possível preparar nichos de 1,0 mm sem atingir a dentina. Há diferenças significativas entre a espessura do esmalte em distal e mesial, antes e depois da preparação dos nichos.

Palavras-chave: Prótese parcial removível; dente suporte; dente premolar; esmalte dentário; dentina

Correspondence:
André Correia
acorreia@fmd.up.pt

Received: July 25, 2012
Accepted: September 19, 2012

Conflict of Interests: The authors state that there are no financial and personal conflicts of interest that could have inappropriately influenced their work.

ISSN: 1980-6523

Introduction

Occlusal rest seats are tooth preparations done with the aim to support occlusal, cingular, incisal or lingual rests [1]. These should be prepared in a healthy enamel, or in metal restorations, and their shape always depends on the tooth morphology that will support them [2].

As an example, in pre-molars or in molars, rests are executed in the marginal crest (mesial or distal) and have a spoon-shaped and triangular outline. The triangle's base is located in the marginal crest and the apex toward the center of the tooth [3].

It is important to know the occlusal rest seat dimensions (Table 1) in order to contribute to the preservation of the abutment tooth structure, avoiding dentin exposure. To do so, it is also necessary to know the enamel dimensions. In premolars it can be situated between 0.99-1.32 mm [4,5].

Table 1. Dimensions (width and depth) of occlusal rest seats. (w.d. without data)

Authors	Width	Depth
Perry [23]	½ distance between B and L cusps	w.d.
Seiden [24]	2.0-2.5 mm	1.0-1.5 mm
Glann and Appleby [22]	1/3 distance between buccal and lingual cusps	1.0-1.5 mm
Carr and Brown [27]	2.0-2.5 mm	1.0-1.5 mm
Miller [25]	½ distance between buccal and lingual cusps	w.d.

These dimensions should allow the fabrication of occlusal rests that guarantee the necessary oclusal-prosthetic equillibrium (better load distribution, prosthesis stability and oclusal relations) and the required strength against oral cavity loads [3,6-10].

From a mechanical point of view, Luk [11] conducted a mathematical analysis on the design of occlusal rests and found an inverse relationship between the rest's mesio-distal dimension and its thickness (or depth). On the one hand, the reduction of thickness of the occlusal rest to values of 1 mm or less, may limit its strength to masticatory loads. On the other hand, we must not cause hypersensitivity, or even irreversible pulp lesions with a major preparation of the occlusal rest [11-13].

From a biological point of view, the wear of dental tissues in occlusal rest preparations is also controversial in terms of the susceptibility of caries. According to Darling [14] rests are areas most susceptibile to tooth decay. Davenport, in 2000, suggests the application of fluor varnish in the rest preparation, to avoid the development of carious lesions. Other authors [14-19] did not find an increase in tooth decay in patients with removable partial dentures. However, they refer to the importance of maintaining an oral hygiene program [14-20].

With this mecanical and biological consideration in mind, Rice [21] examined the laboratory prescriptions written by dentists in Wales and verified that 49% did not require occlusal rests, while only 30% of those who required occlusal rests had some kind of rest seat preparation and only 25% of those were according to the preparation guidelines.

Thus, it seems obvious that occlusal rest seat preparation in RPD is not consentual in clinical practice, although it is recommended in the RPD design guidelines [2,12,15, 22-25].

As the premolars are the teeth normally used as RPD abutments in Kennedy's Class I and II, the aim of this research was to study the depth of occlusal rest seats in premolars and analyze its relation with dentin and enamel, trying to optimize rest seat preparations in clinical practice.

Methods

This sample was randomnly obtained in the population of the university clinic of the Faculty of Dental Medicine of the University of Porto. Twenty-nine human premolars, extracted for orthodontic reasons, with an intact anatomic crown, were used. The mesio-distal and buccal-lingual dimensions were measured with a caliper rule (1/100 mm).

Occlusal rest seats were prepared with rounded burs (1.0 mm), with an external shape of an isosceles triangle, with the vertex directed to the center of the occlusal surface and the other sides corresponding to half the distance separating the buccal and lingual cusps.

The preparation of each occlusal rest seat was terminated with a diamond bur with 1,5 mm in diameter, deepening its base near the vertex in order to achieve the spoon-shaped outline. These preparations were done in the enamel of the mesial and distal fossae of each tooth, by a Removable Prosthodontics Professor from the Faculty.

Using a cutting device (Accutom Hard Tissue Microtome®, Struers, Dinamarca) with a diamond disc (Diamond Cut Off 230 CA®), the rest seats were cut passing through the median area of the base and following a parallel plane to the crown axis. Each sample obtained was immobilized on an aluminum sample holder and then metalized with an ion sputter (Jeol, Fine Coat Ion Sputter JFC 1000®).

To better observe the thickness of the enamel, each element sample was observed in a scanning electron microscope (SEM), in CEMUP (Materials Centre of the University of Porto). Each occlusal rest seat was photographed in SEM with a micron rule to allow the calculation of the observed lengths (Fig. 1 and Fig. 2).

For each sample we have defined four measures in the enamel thickness: (Fig. 3):

- Enamel maximum thickness in the distal wall (a-a')
- Enamel maximum thickness in the mesial wall (b-b')
- Enamel maximum thickness in the deepest part of the rest seat in the distal preparation (C)
- Enamel maximum thickness in the deepest part of the rest seat in the mesial preparation (C)

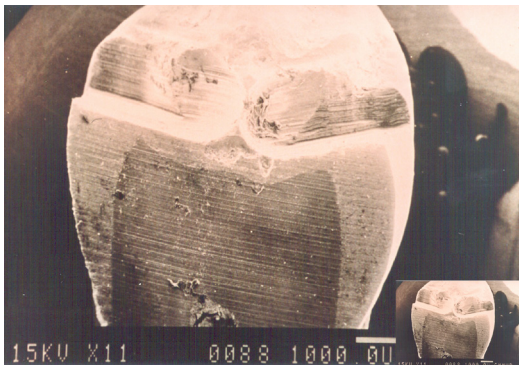

Fig. 1. Scanning electron microscope photography of a premolar tooth with occlusal rest seats prepared in mesial and distal.

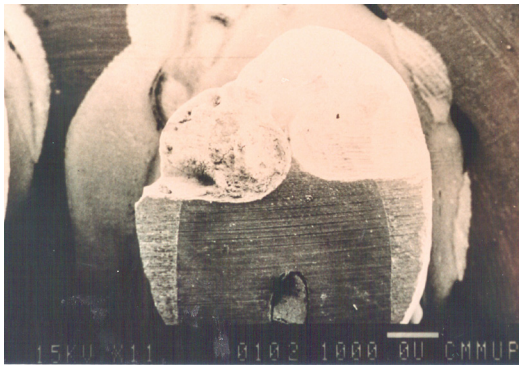

Fig. 2. Scanning electron microscope photography of a premolar tooth with occlusal rest seats prepared.

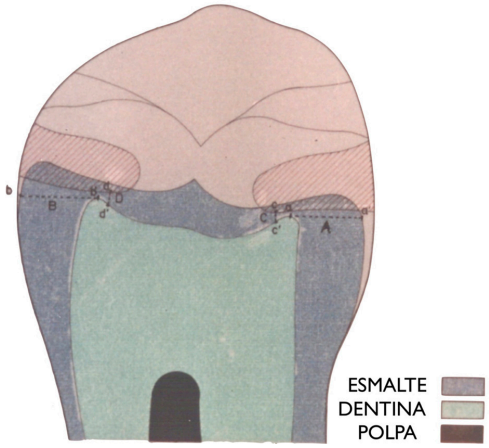

Fig. 3. Representative scheme of the four measures of enamel thickness.

The abrasion level in the occlusal surfaces of the teeth was also evaluated to detect abrasion surfaces, with a magnifying glass and a rasant lightning in the area evaluated. The abrasion was quantified using the abrasion index defined by Gourdon [26].

Results

Enamel dimensions defined in the methodology were measured in each tooth. Though a linear aproximation, with this sample we have tried to analyze, whether the enamel maximum thickness in distal was related to the enamel maximum thickness in mesial, before and after the rest seat preparation, considering the location of the rest seat base in the preparations.

We have determined the average values of enamel maximum thickness. The results were the following:

- Before occlusal rest seat prepartions the statistic value observed was 4.63. With a significance level of 5% and 1% the null hypothesis was rejected. Therefore, there are highly significant differences between enamel maximum thickness in distal and mesial.
- After occlusal rest seat preparation, the statistical value observed was 4.16. With a significance level of 5% and 1% the null hypothesis was rejected. Thus, there are highly significant differences between enamel maximum thickness in distal and mesial.
- As a result, it can be concluded (with a 1% error) that there are highly significant differences between enamel maximum thickness in distal and mesial, before and after rest seat preparation.
- The enamel maximum thickness in the rest seat base, the highest value found was 625 µm in the deepest part of the distal prepararion (Column C), and 500 µm in the mesial preparation (Column D).

Subsequently, we analyzed the occlusal rest seat in its relation to dentin. It was found that in over 50% of cases, the rest seat base was inside dentin (Table 2) (Fig. 4).

Table 2. Location of the occlusal rest seat in relation to dentin. Confidence interval (C.I.) of 95%.

Location	Distal Rest Seat		Mesial Rest Seat	
	%	C.I.	%	C.I.
1 – rest seat base inside dentin	51.72	34.17-68.91	58.62	40.40-74.75
2 – rest seat base in the dentin-enamel border	10.35	0.04-26.79	10.35	0.04-26.79
3 – rest seat base did not reach dentin	37.93	22.44-56.35	31.03	17.06-49.60

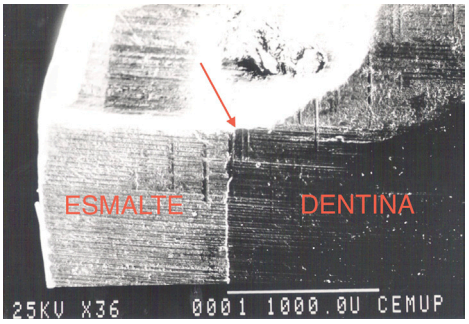

Fig. 4. Scanning electron microscope photography of a premolar tooth with occlusal rest seats prepared. Detail of the dentin invasion (red arrow).

Concerning the abrasion level evaluation, a grade 0 in 79.31% of the teeth (I.C. 61.21%-90.30%, at 95% confidence level) was observed.

Discussion

The results allow us to establish a significant correlation between the thickness of the enamel (A, B, C and D) and the largest mesio-distal and buccal-lingual diameter. Teeth with larger diameters have a thicker enamel, which allows a more conservative preparation of the rest seat.

According to different authors [22,24,27], the rest seats' depth should be 1.0-1.5 mm. However, other authors, like Gapido [28] consider that occlusal rests with an 0.8 mm thickness are sufficient to resist the material's fatigue (in a Co-Cr alloy, and not an alloy of Ag-Pd-Cu-Au).

On the other hand, Sato [13] verified, in a numerical stress analysis study, that the strength of the occlusal rests increases with a greater thickness and width, implying ideal values of 2 mm, which barely remains in the enamel.

In our study, there was a dentin invasion in more than half of the premolars with rest seats prepared (51.72%-58.62%). Jones [29], in 2001, obtained similar results. This author observed a dentin exposure in 61% of the cases, although the rest seats' preparation corresponded to a miminum depth of 1 mm.

This results demonstrate that, although the Professor had the perception that he had not reached dentin, in more that half of the cases there was a dentin exposure, with the consequences that may arise, specially concerning sensitivity, or a higher risk of tooth decay [29].

This less conservative preparation of the rest seats is coincident with the observations of other authors, like Culwick [30], who verify that post-graduate professors and students prepare rest seats with a higher dimension than the general dental practitioner. On the other hand, Zanetti [31], in a study of rest seat preparation in the canines cingulum by Prosthodontic Professors, verified that 85% of the rest seats were insuficiently prepared, 15% excessively prepared, and none had the correct dimensions.

It is also important to note that in the standard clinical practice, the occlusal rest seat preparations are done with older patients (as opposed to the teeth used in this study), where the dentin thickness is higher, the dentin tubules are more closed and there is more peritubular dentin. This fact minimizes possible damage to the pulp, or a greater risk of tooth decay.

Concerning the abrasion level, the majority of the sample (79.31%) reveals a value of zero, which is not surprising given that all the teeth were extracted for orthodontic reasons and, therefore, in an early phase of their function, occlusal or masticatory.

In teeth where the abrasion level is higher than zero, the enamel thickness is lower, leading more easily to an iatrogenic dentin lesion when preparing the occlusal rest seats.

Given these results, there is an evident need to apply higher doses of fluoride components and/or tooth sensitivity products, in the dental office, and in the patient's oral hygiene, after rest seat preparation, since in most cases there is an exposure of the dentin tubules, which must be sealed soon after this preparation.

In order to try to reduce this occurence, it seems correct to suggest that occlusal rest seat preparations in premolars require a 0.5 mm reduction in the antagonist tooth, since we need a sufficient thickness of metal to give rigidity to the occlusal rest, as refered to by Luk [11] and Sato [13].

Conclusions

In the majority of the situations it is not possible to prepare an occlusal rest seat with a 1.5 mm depth totally in enamel.

In teeth with no abrasion surfaces it is possible to prepare rest seats with a 1mm depth without reaching dentin.

There are significant statistical differences between enamel maximum thinckness in distal and mesial, before and after occlusal rest seat preparation.

Acknowledgments

Jonathan Lewis, Professor of the English Course Unit, in the Master Degree in Dental Medicine of the Faculty of Dental Medicine of the University of Porto.

References

1. The glossary of prosthodontic terms. J Prosthet Dent. 2005;94:10-92.
2. McCracken WL. Contemporary partial denture designs. 1958. J Prosthet Dent. 2004 Nov;92(5):409-17.
3. Borel JC, Schittly J, Exbrayat J. Elementos que intervienen en la constitución de una prótesis parcial removible metálica. Manual de Protesis Parcial Removible. Barcelona: Masson S.A.; 2002.
4. Munhoz LO, Vellini-Ferreira F, Cotrim-Ferreira FA, Inês Ferreira R. Evaluation of proximal enamel thickness and crown measurements in maxillary first premolars. Braz J Oral Sci. 2012;11:30-5.
5. Feeney R, Zermeno J, Reid D, Nakashima S, Sano H, Bahar A, et al. Enamel thickness in Asian human canines and premolars. Anthropological Science. 2010;118:191-8.
6. Bates J, Neill D, Priskel H. Abutment preparation for removable partial dentures. Restoration of the partially dentate mouth. Chicago: Quintessence Publishing Co; 1984. p. 259-69.
7. Kratochvil FJ, Thompson WD, Caputo AA. Photoelastic analysis of stress patterns on teeth and bone with attachment retainers for removable partial dentures. J Prosthet Dent. 1981;46:21-8.
8. Lescher MJ, Dimicoli G, Borel JC. Preparation of occlusal rests on lower molars. Odontologia. 1988;9:139-45.
9. Rudd RW, Bange AA, Rudd KD, Montalvo R. Preparing teeth to receive a removable partial denture. J Prosthet Dent. 1999;82:536-49.
10. Davenport JC, Basker RM, Heath JR, Ralph JP, Glantz PO, Hammond P. Tooth preparation. Br Dent J. 2001;190:288-94.
11. Luk NK, Wu VH, Liang BM, Chen YM, Yip KH, Smales RJ. Mathematical analysis of occlusal rest design for cast removable partial dentures. Eur J Prosthodont Restor Dent. 2007;15:29-32.
12. Carr AB, Brown DT. McCracken's Removable Partial Prosthodontics. 12. ed. St Louis, Missouri: Elsevier Mosby; 2011.
13. Sato Y, Shindoi N, Koretake K, Hosokawa R. The effect of occlusal rest size and shape on yield strength. J Prosthet Dent. 2003;89:503-7.
14. Darling A. The pathology and prevention of caries. Br Dent J. 1959;107: 287-96.
15. Anderson J, Bates J. The cobalt-chromium partial denture. Br Dent J. 1959;107:57-62.
16. Bergman B, Hugoson A, Olsson CO. Caries and periodontal status in patients fitted with removable partial dentures. J Clin Periodontol. 1977;4:134-46.

17. Schwalm CA, Smith DE, Erickson JD. A clinical study of patients 1 to 2 years after placement of removable partial dentures. J Prosthet Dent. 1977;38:380-91.
18. Benson D, Spolsky VW. A clinical evaluation of removable partial dentures with I-bar retainers. Part I. J Prosthet Dent. 1979;41:246-54.
19. Vermeulen AH, Keltjens HM, van't Hof MA, Kayser AF. Ten-year evaluation of removable partial dentures: survival rates based on retreatment, not wearing and replacement. J Prosthet Dent. 1996;76:267-72.
20. Owall B, Budtz-Jorgensen E, Davenport J, Mushimoto E, Palmqvist S, Renner R, et al. Removable partial denture design: a need to focus on hygienic principles? Int J Prosthodont. 2002;15:371-8.
21. Rice JA, Lynch CD, McAndrew R, Milward PJ. Tooth preparation for rest seats for cobalt-chromium removable partial dentures completed by general dental practitioners. J Oral Rehabil. 2011;38:72-8.
22. Glann G, Appleby R. Mouth preparation for removable partial dentures. J Prosthet Dent. 1960;10:698-706.
23. Perry C. A philosophy of partial denture design. J Prosthet Dent. 1956;6:775-84.
24. Seiden A. Occlusal rests and rest seats. J Prosthet Dent. 1958;8:431-40.
25. Miller E, Grasso J. Removable partial prosthodontics. 2. ed. Baltimore: Williams and Wilkins; 1981.
26. Gourdon A, Wada A. Mise au point d'un indice d'abrasion. Cah Prothese. 1983;43:115-22.
27. Carr AB, Brown DT. Rests and rest seats. In: Carr AB, Brown DT, editors. McCracken's Removable Partial Prosthodontics. 12. ed. St Louis, Missouri: Elsevier Mosby; 2011. p. 56-66.
28. Gapido CG, Kobayashi H, Miyakawa O, Kohno S. Fatigue resistance of cast occlusal rests using Co-Cr and Ag-Pd-Cu-Au alloys. J Prosthet Dent. 2003;90:261-9.
29. Jones RM, Goodacre CJ, Brown DT, Munoz CA, Rake PC. Dentin exposure and decay incidence when removable partial denture rest seats are prepared in tooth structure. Int J Prosthodont. 1992;5:227-36.
30. Culwick PF, Howell PG, Faigenblum MJ. The size of occlusal rest seats prepared for removable partial dentures. Br Dent J. 2000;189:318-22.
31. Zanetti AL, Mengar MA, Novelli MD, Lagana DC. Thickness of the remaining enamel after the preparation of cingulum rest seats on maxillary canines. J Prosthet Dent. 1998;80:319-22.