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Evaluation of the marginal adaptation of a fibreglass reinforced resin crown using a scanning electronic microscope

Avaliação da adaptação marginal de coroa de resina reforçada com fibra de vidro em microscópio eletrônico de varredura

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- marginal adaptation;
- dental porcelain;
- scanning electron microscope.

Abstract

Introduction and objective: Dental prostheses manufactured using reinforced resins are an alternative to the rehabilitative treatment of one or more dental elements. With the aim of forecasting the longevity of these prosthetic pieces, this study evaluated the marginal adaptation of a complete crown made from fibreglass reinforced resin.
Material and methods: A tooth having orthodontic indication for extraction was prepared and a prosthetic piece was cemented over it so that, 48 hours later, the extraction could take place. The ensemble was taken in a laboratory and was examined using a scanning electron microscope (SEM). There were made 30 readings in a 8mm tooth-cement-restoration interface and revealed various gaps throughout the sample. Results: The lowest value found was 15.82 µm and the highest was 72.81 µm showing an average value of 40.82 µm. Conclusion: The gaps were within the limits of clinical tolerance and considering the clinical difficulty in making the prosthetic piece, the treatment was shown to be satisfactory with regard to marginal adaptation.

Introduction

The success of fixed unitary prostheses is related to factors such as longevity, the health of the dental pulp, periodontal stability and patient satisfaction [8]. With regard to the latter issue, the presence of any quantity of metal whatsoever may motivate conflict on the part of the patient, since there is an increasing demand for metal-free solutions [3]. One of the main factors responsible for treatment failure is marginal adaptation, a critical point for these materials, since faults in this region enable the accumulation of bacterial plaque which is harmful both to the dental roots and to gum and bone health [11], whereby interfaces greater than 100 µm are considered to be unacceptable in clinical practice [4].

Among the materials most used in “metal-free” prosthesis are laboratory made fibreglass reinforced resins (e.g.: the Adoro-Vectris system / Ivoclar-Vivadent, Principality of Liechtenstein) or polyethylene (BelleGlass-Connect system / Kerr, CA – USA).

Behr et al. [1] compared tooth fracture resistance and the marginal adaptation of resins reinforced with polyethylene and fibreglass and concluded that there was no significant statistical difference between the two materials and that, with regard to marginal adaptation, the result further depends on factors such as the bonding system and the cement used. Kolbeck et al. [5] state that, despite having a little difference, fibreglass presented better characteristics than polyethylene fibre in relation to the two properties and emphasizes that better sealing of the edges occurs, regardless of the type of fibre, when the restoration is finished using enamel, and not dentine, due to better cohesion between the bonding system and the cementing agent.

Cho et al. [4] assessed the marginal adaptation of this material according to the preparation design, varying the convergence of the axial walls by six, ten and fifteen degrees, and found that marginal adaptation improved, equivalent to 47 µm, the smaller the inclination of the angles. In a similar
study [6] the authors made this comparison by varying between chamfer, chamfer bevel, shoulder and shoulder bevel cervical finish lines and observed larger gaps in prosthetic pieces using chamfered preparations, although they were within clinical tolerance limits.

Confronting materials used, Monaco et al. [7] compared the marginal adaptation of ceramic and resin reinforced adhesive prostheses with inlay type preparations. When assessing the percentage of the continual margin of the prosthetic piece the authors observed that reinforced resin presented 92.9% margin continuity on the restoration piece-cement interface and 93.3% on the cement-tooth interface and concluded that the more rigid the restoration material used, the greater the tension generated on the edges and, consequently, the better the marginal adaptation and sealing.

This study analysed the marginal adaptation of a fixed unitary prosthesis made using the Ivoclar-Vivadent system.

**Material and methods**

The prosthetic piece was placed over an upper left first premolar tooth recommended for extraction for orthodontic reasons, number of the process committee of ethics 088/2006. The crown preparation was done using a 1mm supragingival chamfer bevel cervical finish line, in order to avoid interferences during the extraction, with 2 mm abrasion on the occlusal face and 1.2 mm abrasion on the proximal, vestibular and palatine faces.

Condensation silicone (Speedex / Vigodent, RJ – Brazil) was selected as the moulding material, and the procedure was performed using the two-step moulding technique. Once the prosthetic piece had been made by the laboratory the cementation procedure was then undertaken using adhesive cement (Rely-X / 3M-ESPE), with prior preparation of the tooth using 37% phosphoric acid and the application of the dual polymerization bonding system (Prime-Bond 2.1 and Self Cure Activator / Dentsply – RJ – Brazil), and preparation of the prosthetic piece using silane (Dentsply).

Following cementation of the prosthetic piece for 48 hours, the dental element was extracted and preserved in a 0.9% sterile saline solution and was then taken to the Fine Films and Surfaces Micromechanics Laboratory at the Department of Physics of the Federal University of Paraná. The sample was held in a support, metallized with gold and analysed using a JEOL JSM-6360LV sweeping electron microscope (SEM), using readings at increments of 30, 100 and 500 times the original size (figures 1 and 2).

The analysis was based on the readings from 30 specific points on the tooth-cement-restoration interface along 8 millimetres of the lingual face of the first premolar. The results of the readings at each point are shown in table 1. The evaluation demonstrated variations between 15.82 µm and 72.81 µm with an average distance of 40.82 µm between the tooth and the prosthetic crown, that is to say, in the 8mm tooth-restoration interface observed there are differences in the thicknesses of the cement to compensate the distances between the tooth and the prosthetic crown.

**Results**

The standard used to evaluate the marginal adaptation of resin reinforced crowns was the measurement of the distance, in micrometers, between the tooth and the restoration by means of S.E.M. observation at increments of 50 and 500 times the original size (figures 1 and 2).

The analysis was based on the readings from 30 specific points on the tooth-cement-restoration interface along 8 millimetres of the lingual face of the first premolar. The results of the readings at each point are shown in table 1. The evaluation demonstrated variations between 15.82 µm and 72.81 µm with an average distance of 40.82 µm between the tooth and the prosthetic crown, that is to say, in the 8mm tooth-restoration interface observed there are differences in the thicknesses of the cement to compensate the distances between the tooth and the prosthetic crown.

![Figure 1](image1.png)

**Figure 1** – Tooth-cement-crown interfaces magnified 500 times

**Table I – Readings at the points along the tooth-cement-crown interfaces**

<table>
<thead>
<tr>
<th>Reading</th>
<th>Gaps</th>
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<td>3</td>
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<td>16</td>
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<td>7</td>
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<td>42.86</td>
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<tr>
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<td>37.46</td>
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</table>
Discussion

Good marginal adaptation is undoubtedly an indispensable factor for the successful longevity of any prosthesis piece. Flaws in relation to this point can be observed principally in the inadequate thickness of the cement film, incorrect cementing techniques and the lack of prior preparation of the piece [9].

The evaluation of the marginal adaptation of a procedure carried out in the mouth shows the difficulties inherent in the process of preparing, moulding and cementing the prosthesis.

The results (table I) demonstrate that the piece functions well in terms of adaptation, as gaps of between 100 and 200 µm are considered to be acceptable in clinical practice [2]. The analysis of the material showed an average value of 40.82 µm (figure 2), in agreement with other authors, such as Cho [4] who found a value very close to the value presented in this study, thus placing the material within the standards of excellent clinical practice.

![Figure 2](image-url) - Interface magnified 50 times. Average interface line of 40.82 µm

Conclusion

The aim of this study was to include the difficulties inherent to the preparation, moulding and cementation of the prosthetic piece in the analysis of the marginal adaptation of fibreglass reinforced resin (Ivoclar-Vivadent system). Considering the results obtained, it can be concluded that the system is a good option for the reestablishment of dental crowns, since it complies with the requirements for good marginal adaptation, diminishing the possibilities of infiltration and recurring caries.

References


