Quantification of marginal leakage area of aesthetic restorations systems used in indirect inlays

Gleidson Rocha Arouca¹
Paulo Sérgio Souza da Silva²
Antonio Fernando Monnerat³
Rogério Luiz de Oliveira Mussel³

Corresponding author:
Rogério Luiz de Oliveira Mussel
University of Rio de Janeiro State – School of Dentistry
157, 28 de Setembro Ave. – Vila Isabel
ZIP code 20551-030 – Rio de Janeiro – RJ
E-mail: mussel@uerj.br

¹ Dental School – University of Rio de Janeiro State – Rio de Janeiro – RJ – Brazil.
³ Laboratory of Quantification in Restorative Dentistry, Department of Restorative Dentistry, Dental School – University of Rio de Janeiro State – Rio de Janeiro – RJ – Brazil.

Received for publication: March 4, 2010. Accepted for publication: June 17, 2010.

Keywords: inlay; quantification; marginal leakage area.

Abstract

Introduction and objective: Marginal leakage of inlays restorations is a key issue for dentists, because of the damaging consequences that its intensity may cause to the tooth, periodontium, and longevity of restoration. The aim of this study was to assess the cervical marginal leakage of two composite systems and a pressed ceramic, through area calculation associated with the longest distance between the restoration and preparation cervical edges. Material and methods: Based on a metal pattern model with MOD inlay preparation, 15 type IV dental stone casts were obtained and randomly distributed into three groups (n = 5) as follows: Empress Group, Sinfony Group, Z350 Group. After restorations had been made, each one was positioned on the pattern model. Following, their mesial and distal faces were photographed in order to analyze marginal cervical leakage through a computer software program. Results: Cervical marginal leakage area: there was statistically significant difference among the three groups (P<0.05). Empress Group presented the highest values, followed by Sinfony and Z350 groups. Empress and Sinfony groups showed, respectively, a leakage area of 280% and 110% higher than Z350 group. Longest distance between restoration
and preparation edges: Statistically significant differences were not observed between Empress and Sinfony groups; however, they showed statistically significant ($P<0.05$) differences when compared to Z350 group (215% and 120% greater leakage than Z350 group, respectively). **Conclusions:** Considering the cervical marginal leakage area calculation and the longest distance between restoration and preparation edges, marginal leakage was smaller in Z350 group followed by Sinfony and Empress groups. In the analysis of cervical marginal leakage, all groups were clinically acceptable.

**Introduction**

The increasing demand for aesthetical restorations on posterior teeth has intensified the development of restorative systems for indirect ceramic and composite resin restorations. Marginal adaptation of dental restorations shows a great clinical importance, since its discontinuity at tooth/restoration allows the formation of a site for dental plaque biofilm [5, 6, 10, 18, 20].

By analyzing this question, several methods have been described for quantifying marginal adaptation of indirect restorations, both *in vivo* and *in vitro* models. *In vivo* studies generally comprised measurements by using dental probe and mirror, and radiographic exams [7, 8, 11, 12, 17]. However, most of the *in vitro* studies use the assessment by silicone or cementation replication. In such techniques a cut in the specimens' mesiodistal direction is performed, obtaining the linear measurement between the inner surface of the restoration and preparation at its cervical terminus [1, 2, 3, 4, 8, 9, 13, 16, 19, 22, 23].

The aim of this study was to assess the marginal leakage of two indirect aesthetical restorative systems – Empress e.max (Ivoclar, Liechtenstein) and Sinfony (3M Espe, USA), and a direct one – Z350 (3M Espe, EUA) through the calculus of its area at the cervical third and also of the linear measurement found at the longest distance between the restoration and preparation cervical edges.

**Material and methods**

In an acrylic upper first molar (Columbia Dentiform Corp., USA) a mesio-occlusal-distal inlay preparation was performed with a 12° divergent walls, from cervical to occlusal surface, rounded angles, and without bevel. Occlusal box depth was approximately 2 mm; proximal boxes were 3.5 mm depth with an occlusal isthmus of half of the intercusp tip distance. From this pattern, through dental casting investment (MicroFine 1700 Talladium, USA), followed by resin volatilization in electric stove (EDG), a master model melted in nickel-chrome alloy was obtained (Fit Cast V Talladium, USA) (figure 1).

**Figure 1** – Photograph of the master model melted in nickel-chrome alloy

Based on this model, 15 impressions were executed by using polyvinylsiloxane (Aquasil, Dentsply, Detrey, Germany), from which 15 dies of type IV dental stone were obtained (Durone, Dentsply). These were randomly distributed into three groups: Empress group ($n = 5$), in which restorations employing the Empress e.max system (Ivoclar, Liechtenstein) were executed; Sinfony group ($n = 5$), in which restorations employing the Sinfony system (3M Espe, USA) were performed; and Z350 group ($n = 5$), in which restorations employing Z350 composite resin were made (3M
Espe, USA). Empress and Sinfony restorations were constructed in accredited laboratories according to the manufacturer’s instructions. In Z350 group, the dies received three coats of die spacers (Pico Fit Remfert, Germany), followed by the application of a die insulate (Insulate Gel, Kulzer, Germany). Composite resin was incrementally inserted, beginning by the cervical surfaces and ending at the occlusal surface; each increment was light-cured (Unix, Kulzer, Germany) for 90 seconds. By the ending of the restoration construction, this was removed from the die and light-cured for 180 seconds.

For the morphometric analysis of the cervical misfit, the restorations were photographed at their mesial and distal surfaces, on the master model. The model was delimited between the cervical and medium thirds [14]. All photographs were obtained at a fixed distance of 4 cm between the surfaces, with lens of a 12.1 megapixel digital photographic camera (Sony Cyber-shot DSC-W215), image at 1:1 ratio, at macro mode. In these same conditions, a photograph was taken of a millimetric ruler for posteriorly calibration of the image’s analysis software (Image-Pro Plus, version 5.0 Media Cybernatics, Silver Springer, USA). After the software importation of the millimetric ruler image and its calibration, photographs to be analysed were also imported. In order to assess the cervical misfit, the polygon tool was used for delimitating the sequential points, the perimeter between the restoration and preparation’s cervical edges. These were limited, at their extremities, by marks on the master model, which corresponded, approximately, to the limit between the cervical and medium thirds, that is, a bidimensional measurement (figure 2, PG1). In order to measure the longest distance between the restoration and the preparation’s cervical edges, the union tool of two points were used, that is, a linear measurement (figure 2, L1).

Concentration to the cervical leakage, all groups showed statistically significant differences among each other. The worst result was demonstrated by the Empress, followed by Sinfony, and Z350 group, which have the best performance. Empress and Sinfony showed, respectively, a cervical leakage area of 280% and 110% greater than the cervical leakage of Z350 group.

In relation to the longest distance between the restoration and preparation’s edges, the best performance was presented by Z350 group, with statistically significant difference. Empress and Sinfony groups show a leakage of 215% and 120%, respectively, when compared to Z350 group. Empress and Sinfony results were not statistically significant; however, Empress shows a leakage value 43% greater than Sinfony.
Table 1 - Calculus of the descriptive analysis of the areas (mm²) and the longest distance (mm) obtained by the perimeter between the cervical edge of restoration and preparation, considering the cervical third

<table>
<thead>
<tr>
<th></th>
<th>Empress</th>
<th>Sinfony</th>
<th>Z350</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (mm²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.958a</td>
<td>0.525b</td>
<td>0.249c</td>
</tr>
<tr>
<td>SD</td>
<td>0.104</td>
<td>0.225</td>
<td>0.088</td>
</tr>
<tr>
<td>Longest distance (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.176a</td>
<td>0.123a</td>
<td>0.056b</td>
</tr>
<tr>
<td>SD</td>
<td>0.025</td>
<td>0.039</td>
<td>0.018</td>
</tr>
</tbody>
</table>

SD – standard deviation. Different alphabetic symbols show significant statistical difference (P ≤ 0.05)

Figure 3 – Photographic images that indicate the leakage pattern prevailing in the Empress (A), Sinfony (B), and Z350 (C). The white outline delimitates the perimeter of the leakage area and, the vertical white line determines the longest distance between the restoration and preparation's cervical edges, taking into consideration the cervical third (horizontal black marks)

Discussion

The aim of this study was to evaluate the cervical leakage of inlay restorations constructed by using three different aesthetic materials, through indirect technique. For this purpose, the calculation of the cervical leakage area at the cervical third and the longest distance between the restoration and preparation's cervical edges were performed. We observed expressive statistical differences among the tested groups, regarding to the evaluated items.

It is worth noting the positive performance of Z350 concerning to the cervical leakage area, showing statistical difference when compared to the other materials studied. Empress and Sinfony presented, respectively, leakage area of 280% and 110% greater than Z350. It is very likely that these findings be associated to the major volumetric contraction of ceramics compared to composites, during the restoration construction's steps. The results found by this study also showed statistical difference between the composite resin groups (Sinfony and Z350). This is contrary to the literature searched. Always through linear measures, several authors [9, 19, 21] reported a statistically greater cervical leakage of the ceramic systems when compared to composite resins, affirming that there would be no difference when composite resins were compared. In our study, in which a difference between the two composite resins was showed, the area calculation was employed. This is a bidimensional measurement, being more informative, in a quantitative point of view, than the width measurement [15].

The linear measurement analysis of the longest distance between the restoration and preparation’s cervical edge is justified by the irregular topography presented by the restoration's cervical edge. In this measurement, the lowest results showed by Empress and Sinfony groups were important, although they did not present statistically significant differences. Empress displayed a linear leakage of 43% greater than Sinfony, and both presented, respectively a linear measurement of 215% and 120% greater than Z350 group. Once more, this is not in agreement with the literature searched [1, 2, 3, 4, 8, 9, 13, 16, 19, 22, 23], where a difference between the composite resin groups were reported. The reviewed literature employed the silicone or cementation replication technique, in which a central cut is made, at the mesiodistal direction, and the linear measurement is obtained between the inner surface
of the restoration and the preparation, specifically along the cervical edge. It seems that the arbitrary selection of the area’s image of the longest linear distance between the preparation and restoration edges determined this difference.

We demonstrated that although the Empress and Sinfony groups were statistically significant between each other, concerning to the longest distance between the restoration and preparation edges, the maximum individual values found in these two groups were lower or very close to 150 µm, which according to literature would be the acceptable level for clinical practice [4, 16, 22, 23]. Therefore, although the numbers suggest a better performance of Z350 group, for this measurement, the other two groups can be considered as options for cervical edge adjustment. Cervical edge fit is critical not only due to factors, such as discontinuity at tooth/restoration limit with consequences in tooth and periodontium integrity itself, but also focuses on the problems inherent to the resin cement and its limitations, such as resin matrix’s dissolution by oral fluids, provoking long-term loss of marginal sealing [7].

Our investigation exposes a methodology for being used in the quantification of the tooth/restoration interface: allowing the area instead of the linear analysis. The study of the cervical leakage and the longest distance between the restoration and preparation cervical edges constitutes a tool capable of identifying the discrepancies provided by the restorative systems used, as well as, the sites where these were more or less intense.

Conclusion

Based on the obtained data, it can be concluded that both for the calculus of the cervical leakage area and the longest distance between the restoration and preparation cervical edges, Z350 showed a smaller cervical leakage, followed by Sinfony and Empress. All the materials presented a clinically acceptable level of marginal cervical leakage.

References


How to cite this article:
Arouca GR, Silva PSS, Monnerat AF, Mussel RLO. Quantification of marginal leakage area of aesthetic restorations systems used in indirect inlays. RSBO. 2011 Jan-Mar;8(1):30-5.