Abstract
The aim of this study was to evaluate the marginal discrepancy of electroforming copings, before and after the porcelain application, varying the cervical preparation of the crowns. Two master dies were prepared with stainless steel to complete crown margin designs: chamfer and rounded shoulder. The impressions were taken with a polyvinylsiloxane by the double impression technique and, the insertion and removal axis were standardized by a dental surveyor. Ten type IV plaster dies from each cervical margin were obtained, on which a die spacer was applied before duplicate. The duplicated dies received a silver layer and connected to a copper wire to enable the gold electrodeposition. After cleaning and adjustments all specimens were examined under a microscope (magnification X 30). The marginal gap was measured before and after ceramic application. The results were elaborated by descriptive statistical and two-way analysis of variance (ANOVA). The ANOVA revealed no significant difference between marginal gap before and after the ceramic application (p=5%). It was concluded that the porcelain application does not influence the marginal fit of copings, therefore the two marginal endings can be used with the electroforming system.

Key Words:
electroforming, crowns, margin design, marginal fit.
Introduction

Metal ceramics restorations are widely used in the crowns manufacture and fixed partial dentures\(^1\), and the margin fit of artificial crowns has been the focus of various investigations, which can suffer alteration during the firing cycle of porcelain.

The existence of a marginal gap promotes a discontinuous junction, forming a powerful biofilm niche; gingival inflammation; allowing gingival and bacteria fluid microleakage, which cause recurrent caries and pulpitis and decrease the longevity of the prosthetics restorations.

Widely used in laboratories, the technique of lost-wax casting involves a series of precaution\(^2\) as well as laboratories steps\(^3\) that can negatively affect the prosthetics restorations sealing. Thus, the interest in the metal ceramics restorations manufacture using less number of laboratories steps has increased, as the system of pure 24-carat gold electroforming.

The use of electrodeposition was first carried out for dental indications during the early 1961 with Rogers and Armstrong\(^4\) describing the laboratories steps for the confection of a gold matrix and gold alloy on it. In a series of articles, the type of union between cast gold dental alloys and an electroformed matrix and gold alloy on it. In a series of articles, the type of union between cast gold dental alloys and an electroformed gold matrix in an inlay technique, metallographics analyses and the fabrication of ceramometal crowns were described\(^4\).

The direct electrodeposition on a plaster die offers as advantages less distortion and better adaptation, then the elimination of laboratories necessary phases to the conventional technique, propitiating uniform thickness of the metallic substrate (0,2mm), porosity absence, high resistance after the application of ceramics, biocompatibility with adjacent tissue and facility to the ceramist in enhance the esthetics\(^1,11-19\).

In literature few studies evaluated the electroformed crowns adaptation, existing little consensus for the correct type of marginal designs to be used in the dental prepare. For this, this study evaluated the differences in the absolute marginal discrepancy of electroformed crowns, before and after the porcelain application, varying the cervical preparation.

Material and Methods

Two master die were prepared with stainless steel, one with a chamfer margin and another with a rounded shoulder margin, which represented endings for metal ceramics restorations of a maxillary lateral incisor (Figure 1 and Figure 2).

For each steel die, ten impressions with a polyvinylsiloxane impression material (Elite, Zhermack S.p.A., Badia Polesine, Rovigo, Italy) were taken by the double impression technique and the insertion and removal axis was standardized by a dental surveyor, designed specially for this purpose (Figure 3). To establish a pattern for impression with the heavy impression, a relief of a 1.4mm thick acetate sheet was confectioned under vacuum, being this used in both dies.

In the dental surveyor anchorage the a device was fixed allowing the placement of specially constructed trays in the same position and in the mobile vertical stem a thread was shaped to allow the steel dies attachment. During the impression the mobile vertical stem was lowered, stopping the screw of the sheath, and the depth of the impression was standardized by the existence of a spring between the fixed horizontal stem and the mobile vertical stem.

The impressions were poured with type IV plaster (Super Ex-3 Porcelain Rock Whrite, Noritake – Dental Stone, Nishikamogun, Aichi - Japan), and trimmed dies were identified. After identification two layers of die spacer (Tru-Fit, George Taub Products & Fusin Co., Jersey City, New Jersey - EUA) were painted within 1mm of the finish line\(^15,20\), as recommended by the manufacturer. The thickness of die spacer was approximately 25µm\(^15\).

The duplication of the plaster die was made with polyvinylsiloxane (Elite Double – Zhermack S.p.A., Badia Polesine, Rovigo, Italy) and the impression were poured using a type III plaster (Durone - Dentsply, Nova Iorque, Pensilvânia, EUA), and a small copper wire was attached with cyanoacrylate cement into a small hole drilled 2mm below the cervical margin. Two layers of silver conducting lacquer were painted over the surface, extending slightly over the finished line of the preparation and a thin strip of silver lacquer was also used to connect the painted die to the copper wire, allowing the passage of galvanic current. The dies were placed in a beaker and immersed in a gold electrolyte solution (GAMMAT free – Gramm Technik, Tiefenbronn, Muehlhausen - Germany) to initiate the electrodeposition process.

After deposit the gold coping, the copper wire was disconnected and the coping separated from the plaster with gypsum remover in a ultrasonic cleaner. The copings returned to the first plaster die and the margins were trimmed with rubber polisher.

The copings were tried onto the stainless steel die, which was fixed in an octagonal base, to evaluate the marginal adaptation in eight different sides. The coping stabilization on the master die was made with a device developed for it (Figure 4). The plunger was lowered and stabilized, locking the lateral screws and remaining a constant force.

The marginal fit of each specimen was checked under optical microscope with 30X magnification (Olympus Microscope Precision STM, Japan) and precision of 0,5µm. Measurements were taken from the cavosurface angle of the preparation to the margin ending for each specimen. This measurement is named “absolute marginal discrepancy”. Three measurements for each side were made, obtaining the arithmetic mean of this region. When finished the measurement of a side, the lateral screws were untied and the octagonal base turned, initiating the measurement process of another side. At the end, the eight values obtained during the measurement of a coping were submitted to an
Before the porcelain application, the copings were embedded in investments to first fire to minimize deformation. After the investment removal, a bonding agent was used, proceeding with the application of two layers of opaque porcelain, two layers of body and glaze (Noritake EX, Noritake, Nishikamogun, Aichi - Japan), using a silicone template. The crowns were adjusted with a rubber polisher and new measurements were taken following the same procedures described previously. For each group, the mean measurement value in each stage was calculated. The results were statistically processed with two-way variance analysis (ANOVA) with significance level of 5%.

Results
The mean descriptive statistics data and standard deviation are represented in table 1 and Figure 5. The absolute marginal discrepancy for the cervical preparation in chamfer with (CHW) and without (CHWT) the porcelain application was 22.582µm and 29.774µm, respectively. For the rounded shoulder with (RSW) and without (RSWT) the porcelain application were 23.020µm and 26.779µm, respectively.

The two-way analysis of variance (ANOVA), with repeated measures (porcelain, repetitive factor), considering the factorial 2X2 (cervical preparation x porcelain) with \( a = 5\% \), showed that there was not a statistically significant difference between the interactions (Table 2).
Table 1: Descriptive statistics data (µm).

<table>
<thead>
<tr>
<th></th>
<th>CHW</th>
<th>CHWT</th>
<th>RSW</th>
<th>RSWT</th>
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<tr>
<td>N</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>MEAN</td>
<td>22.582</td>
<td>29.774</td>
<td>23.020</td>
<td>26.779</td>
</tr>
<tr>
<td>SD</td>
<td>16.049</td>
<td>18.663</td>
<td>10.671</td>
<td>9.5959</td>
</tr>
</tbody>
</table>

Table 2: Analysis of variance results (µm).

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margin (A)x(B)</td>
<td>1</td>
<td>16.34</td>
<td>16.34</td>
<td>0.05</td>
<td>0.8208</td>
</tr>
<tr>
<td>A*B</td>
<td>18</td>
<td>5566.82</td>
<td>309.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Porcelain (C)</td>
<td>1</td>
<td>299.81</td>
<td>299.81</td>
<td>3.10</td>
<td>0.0952</td>
</tr>
<tr>
<td>A*C</td>
<td>1</td>
<td>29.46</td>
<td>29.46</td>
<td>0.5877</td>
<td></td>
</tr>
<tr>
<td>A<em>B</em>C</td>
<td>18</td>
<td>1739.77</td>
<td>96.65</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>7652.22</td>
<td></td>
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</table>

Discussion

The appropriate examination of the restoration marginal fit in its respective tooth is very difficult in the clinic, demanding extreme ability and sensitivity of the dentist. This analysis can be done by radiographic and an explorer examination, techniques that many times don’t allow a direct and accurate vision, having the necessity of obtaining prosthesis with the minimum laboratorial distortion.

The laboratorial steps as the process of invest; type of refractory investment; type of alloy and the casting associates to the clinical steps, as the type of cervical preparation; impression material; axis of insertion and removal of the impression; types of cement; retention grooves and pressure during cementation can increase the marginal discrepancy. To eliminate the clinical steps effect, the copings cementation and the confection of the retention grooves were not accomplished, remaining the pressure of the seating in measurements constant.

The precision and fidelity of the die were achieved by impressions with polyvinylsiloxane by the double impression technique, using a dental surveyor prepared specifically for this study, being the metallic die removal force and the impression possible alterations in the cervical region equally transmitted in all its perimeter.

Previous studies that measured the marginal fit of electroformed crowns are divergent related to the cervical designs and methodology. According to the manufacturer, the most indicated is chamfer, however the studies results of Setz et al. and Huls and Rinke, the cervical design in rounded shoulder could be used, reason for which this study compared both in the same conditions. Using the recommended cervical endings, it is observed that the confectioned crowns by the electroforming technique present smaller marginal discrepancies when compared to the lost-wax casting, however the use of cements with a larger film thickness can affect the final result.

The bevels use for this system is not indicated; because they would provide a very thin thickness of pure gold, causing distortions during the porcelain firing. This was observed by Patennó et al., that after the application of the porcelain verified sensible increase of the marginal gap that passed from 14µm to 34µm and for Hammerle et al. (1994) that obtained worse results for the electroforming system (53.7µm) when compared to the lost-wax casting method (36µm).

In studies of Setz et al. and Huls and Rinke the entire coping circumference was evaluated, what was not accomplished in this study, and during our measurements could be observed that beside the 8 positions the adaptation was perfect, fact observed in practically all specimens. This way, it was expected that if the reading of the whole circumference was accomplished the found results would be smaller.

In this study there was not a statistically significant difference between the two marginal designs, before and after the porcelain application. The marginal gap decrease after the application of the porcelain is discordant from literature, however we believe that it happened due to the final finishing with a rubber polisher that closed the edge, acting as burnishing. In the same way, as the gold deposition occurs on the silver lacquer, slightly applied below the cervical margin, we expected that no type of marginal gap be found. However, it exists and we believe that it can have occurred during the laboratorial finishing steps, evidencing the importance of a rigorous laboratorial protocol.
Conclusions
In despite of restrictions of this in vitro investigation, the following conclusions may be drawn: both cervical endings can be used with the electroforming system and the porcelain application does not influence in the marginal fit of the electroformed crowns.

References