STUDY ON THE MECHANICAL BEHAVIOR OF THE AESTHETIC INLAYS

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ABSTRACT

The aim of this study was to investigate the fracture resistance of unprepared and restored teeth, comparing the compression behavior of two important materials used for inlay realization-composite resins and ceramics. 80 human teeth, were extracted due to periodontal or orthodontic reasons (40 premolars and 40 molars). The teeth were randomly divided into three groups. Each group contained 20 teeth - 10 premolars and 10 molars, and stored in water for one week.

The first group acted as unprepared, control group. The second group was prepared and received resin composite inlays and the third one received ceramic inlays. The teeth were loaded to failure using a testing machine through a 2 mm diameter stainless steel rod. The results demonstrate that the unrestored teeth have the higher fracture resistance. Statistical analyses show that there are no significant differences between the restorative materials: resin and ceramic. This study draw the conclusions that the fracture resistance is influenced by the material properties and the modality of forces transmission to the dental tissues.

Key words: aesthetic inlays, fracture resistance, mechanical behavior

INTRODUCTION

Inlays are high-precision prosthetic restorations, which allow a very good restoration of the coronary morphology and have a higher mechanical strength than conventional dental fillings. Their longevity in the oral cavity depends, on the one hand, on the accuracy of the clinical steps (judicious establishment of treatment strategy, teeth preparation, correct impression, cementation), and, on the other hand, on the correct choice of the appropriate material and on the observance of the technological steps, knowing the particularities of each method [1,2].

The very first materials used for inlays were the gold alloys, which have long been considered as perfect materials for posterior restorations and ideal materials for inlays.

Although today's interest in metal restorations has decreased greatly, as a result of the appearance of high-performance esthetic materials, gold alloy remain a benchmark for marginal adaptation and durability over time.
However, the aesthetic requirements have increased more and more, and modern materials - composite resins and ceramic masses - respond to these physiognomic demands, and are also mechanically appropriate, as well [3,4].

Regarding the longevity in the oral cavity of composite incrustation, the short-term results are encouraging. For ceramic inlays, in addition to the classical techniques, were implemented, as well as the computerized technologies, which have the advantage of eliminating the laboratory steps, thus avoiding possible errors and of using ceramic blocks made industrially, with superior mechanical properties [5,6,7,8].

MATERIALS ŞI METHODS

In order to perform this comparative analysis, we selected 80 human teeth, 40 upper premolars and 40 upper molars, with no cracks, caries, lesions or restorations, extracted for orthodontic or periodontal reasons. The teeth were cleaned of any traces of periodontal tissue or tartar deposits, using a Gracey curette, washed with a 2% sodium hypochlorite solution, and then kept in distilled water for one week. Before beginning the experiment, the teeth were fixed with the roots in to an acrylic block with a height of 20 mm and a diameter of 15 mm; the acrylic blocks were mounted in stainless steel molds with self-curing acrylic resin, to within 2 mm of the cemento-enamel junction (fig.1).

Fig.1 Unrestored teeth- control group

The teeth were loaded to failure using a testing machine through a 2 mm diameter stainless steel rod; the samples were divided into three study groups (table I):
| Group 1          | Unrestored teeth               | - 10 Premolars  
|                |                                | - 10 Molars     |
| Group 2        | Teeth restored with composite inlays | - 10 Premolars  
|                |                                | - 10 Molars     |
| Group 3        | Teeth restored with ceramic inlays | -10 Premolars  
|                |                                | -10 Molars      |

Table I: The study groups

On the premolars and molars of groups 2 and 3, mesio-occlusion-distal cavities were prepared, using diamond turbine mills, under continuous cooling. The occlusal cavity was performed with a depth of 3 mm at the isthmus level between the horizontal and vertical cavities. The proximal cavities were prepared with a mesio-distal dimension of 4 mm, and their cervical-occlusal diameter is also 3 mm. The lateral walls of the occlusal and proximal cavities have a 6° divergence towards the occlusal side, to allow the unforced insertion of the prosthetic piece; the cervical threshold was performed in a 90° angle. All the angles were rounded to avoid the occurrence of internal tensions in the restoration and its fracture.

The samples of the second group was restored with light and heat composite resin, Clearfil CR Inlay® (Kuraray); the inlays were fixed with Variolink N resin, a dual-cure and light-cure luting composite for indirect restorations (fig.2)

![Fig. 2 Premolars and molars restored with composite inlays](image)

The third group was restored with ceramic inlays, using the IPS Empress (Ivoclar) system, a glass-ceramic extremely homogeneous, leucite-based. For cementation we used Variolink N resin (fig.3).

In order to assess the biomechanical characteristics of the dental tissues and of the
restorative materials, we analyzed the compression application for each study group separately.

Fig.3 Premolars and molars restored with ceramic inlays

The research was done using a universal testing machine; the installation is equipped with computer-assisted acquisition equipment of experimental data, which allowed the visualization, in the form of curves, the loading force until the first crack appeared, for each sample.

The speed of the machine was 18mm / minute.

The compression behavior represented by diagrams, made possible a comparative analysis, noticing the maximum value of the loading forces causing the very first fracture line, as well as the mechanical behaviour of the three types of studied materials.

The results were statistically processed and compared using the analysis program SPSS.

RESULTS AND DISCUSSIONS

The resistance of restored teeth was different, even the differences are not statistically significant. Considering this behavior, it was necessary to analyze how the crack occurs; For this purpose we studied the fracture pattern in each group, looking at whether the crack comprises only the tooth, a portion of it or involves the restoration. The analysis of the fracture pattern allow us to draw conclusions regarding the link between the tensions generated during the functional requests and the modality of transmission to the dental structures.

In group 1, the control group, the most frequent fractures occurred on the oral cusps, 90% of cases in premolars and in 85% of cases in molars (fig.4).
In group 2, represented by teeth with composite restorations, it is found that the fracture comprises the oral cusps and a portion of the restoration, both in premolars and first molars (fig.5).

Fig.5 Fractures in teeth restored with composite inlays

In group 3, which includes the samples with ceramic reconstructions, we find the fracture of the oral cusps and the complete fracture of the restoration, due to the fact that the ceramic is a brittle material (fig.6).

Fig.6 Fractures at the teeth restored with ceramic inlays

The tooth-restoration complex, subject to compression, behaves differently due to the different mechanical properties of the materials, on one hand, and on the other, due to the connection at the interface level. For a better understanding of the phenomenon, we observed comparatively the modulus of elasticity of the studied materials.
<table>
<thead>
<tr>
<th>Biomaterial</th>
<th>Modulus of elasticity (GPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enamel</td>
<td>50-80</td>
</tr>
<tr>
<td>Dentin</td>
<td>15-20</td>
</tr>
<tr>
<td>Composite resin</td>
<td>10-18</td>
</tr>
<tr>
<td>Ceramic</td>
<td>50-80</td>
</tr>
</tbody>
</table>

We noticed that the ceramic has a modulus of elasticity close to that of the enamel, while the composite resins approach the value of the modulus of elasticity of dentin [9, 10]. Before fixing the inlays, the surface of the tooth and the restoration is treated with acid, which leads to the appearance of additional retentions and improving the connection at the interface level. At the moment of fracture, in case of composite restorations, a portion of the tooth and the coronary restoration will crack, as a result of a strong adhesion between the two materials, while in case of ceramics, the restoration will be completely fractured, which the needles demonstrate a weaker connection between tooth and restoration [11,12,13].

**CONCLUSIONS**

Using the mechanical tests we registered that the unrestored teeth have a better fracture resistance than the restored teeth, the prosthetic reconstruction, regardless of the chosen material, failing to bring the tooth to the initial biomechanical parameters.

Analyzing the two groups of teeth that were subjected to the study, the premolars and molars, no significant differences were observed regarding their mechanical behavior, neither in the control group nor in the groups on which the inlays were applied.

The most common fractures occur on the oral cusp, and on the group with composite inlays, the reconstructions were also interested. This shows that acid attack and application of bonding agents highly improves the quality of the dento-prosthetic joint.

The fracture resistance of the analyzed samples being the same, we can conclude that the longevity of inlays is influenced less by the resistance the material from which the restoration is performed and more by the way in which the stress generated by the functional requests is transmitted to the dental structures.
and also by the quality of the interface. The results lead us to the conclusion that in order to have inlays with a marginal adaptation as best as possible, the cementing material must be in the smallest quantity and the connection between the tooth and the restoration must be strong.

BIBLIOGRAPHY