

# In vitro investigation of polyglass and ceromer veneers abrasion related to cobalt-chromium circumferential clasps\*

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## ABSTRACT

The purpose of this study was to investigate *in vitro* the behaviour of polyglass and ceromer veneers when submitted to insertion and removal of removable partial denture circumferential clasps. Twenty-four veneer crowns (12 made of polyglass and 12 made of ceromer), as well as the respective cobalt-chromium circumferential clasps were made. Using a proper device, the crowns were then submitted to five thousand cycles of clasp insertion and removal. The verification of the force necessary to remove the clasps over the crowns during the experiment and the macroscopic inspection of the crown veneers were used to evaluate the effects of cycling over the test specimens. The force necessary to remove the clasps over the crowns did not change significantly during the cycling. However, all crown veneers showed an abrasion area, noticed by macroscopic evaluation. By these results, one can conclude that veneers made by polyglass and ceromer suffered abrasion by cobalt-chromium clasps insertion and removal, but this abrasion did not influence significantly the force necessary to remove the clasp over the crowns during the experiment.

## UNITERMS

Removable partial dentures, clasps; dental crowns, laboratory resins

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## RESUMO

O objetivo deste estudo foi investigar *in vitro* o comportamento das facetas de *Artglass* e *Targis* quando submetidas   inserç o e remoç o de grampos circunferenciais de cromo-cobalto. Foram confeccionadas 24 coroas *veneer* (12 com facetas de *Artglass* e 12 com *Targis*), bem como os respectivos grampos circunferenciais em cromo-cobalto. Utilizando um dispositivo elaborado para este fim, as coroas foram submetidas a cinco mil ciclos de inserç o e remoç o dos grampos. Para avaliar os efeitos dos ciclos sobre os corpos-de-prova, foram utilizadas a verificaç o da forç  necess ria para remover os grampos das coroas e a inspeç o macrosc pica das coroas. A forç  necess ria para remoç o dos grampos das coroas n o foi alterada significativamente durante o experimento. Entretanto, todas as coroas apresentaram uma  rea de abras o, observ vel por inspeç o visual. Deste modo,   poss vel depreender que as facetas feitas com *Artglass* e *Targis* sofrem abras o decorrente da inserç o e remoç o de grampos circunferenciais em cromo-cobalto, mas esta abras o n o influenciou significativamente a forç  necess ria para remover o grampo da coroa durante este estudo.

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## UNITERMOS

Prótese parcial removível, grampos; coroas, resinas laboratoriais

## INTRODUCTION

The removable partial denture (RPD) needs to have sufficient retention to resist against the dislodgement generated by forces of high intensities. The retention of a RPD is mechanically obtained by the relation of the bases of the saddles and major connectors with the subjacent tissues and by placing direct retainers of the RPD on the abutment teeth<sup>9</sup>.

The direct retainer is a component of the RPD that is attached to the abutment tooth impeding the dislodgement of the denture. The direct retainer can be located intracoronally or extracoronally (being this last one more used in RPD construction).

Among the extracoronally located direct retainers, the circumferential clasp is the type of clasp most frequently used in RPD construction, and it is the basis for all types of clasp design<sup>4</sup>.

In order to avoid the dislodgement caused by vertical forces, it is necessary to put the flexible third of the retentive arm passively in an adequate undercut zone of the abutment tooth. The alloy's resistance against deformation (to which the flexible third is submitted when it crosses the zone of maximum contour) added to the tripping action of the arm over the tooth surface gives the resistance against the movement of the RPD. Some articles in the literature<sup>5,8,17,18</sup> have demonstrated that these factors could generate abrasion in some dental materials.

About RPD planning, when it is possible, edentulous spaces should be filled with fixed partial dentures, mainly in the anterior part of the mouth. This procedure simplifies the design of the RPD, and facilitates the establishment of the path of insertion and the reciprocity during insertion and removal<sup>10</sup>.

In addition, the fixed splint of two weak support teeth could bring an adequate support for a RPD. In other situations, the patient comes to the dentist to make a RPD wearing crowns or fixed bridges in his or her abutment teeth.

A new type of aesthetic material is being used to make fixed crowns or bridges, called second generation laboratorial composite resins<sup>21</sup>. To be designed as that, the material has to present some characteristics like high percentage of inorganic fillers (an average of 66% of inorganic fillers and 33% of resin matrix), minimum polymerisation shrinkage and good bonding to the copings, irrespective of the alloy used. These materials are also named *polyglass*, because of the glass fillers (barium silicate)<sup>16</sup>, or *ceromer* (*ceramic optimised polymer*).

They are indicated for inlays, onlays, for veneering fixed conventional and implanting-supported bridges, metal-free fixed bridges as well as to make periodontal splints<sup>15,24</sup>.

Considering the necessity of the clinician to make fixed bridges or crowns conjugated to a RPD<sup>10</sup>, the abrasion of some materials related to insertion and removal of RPD clasps<sup>5,8,13,14,17,18,20</sup>, the increasing use of polyglass and ceromer<sup>12</sup> and the absence of articles on abrasion of these resins related to insertion and removal of RPD clasps, the purpose of the present paper was to investigate the behaviour of the polyglass and ceromer veneers when submitted to the insertion and removal of cobalt-chromium circumferential clasps.

## MATERIALS AND METHODS

Twenty-four crowns of a first mandibular molar were made of copper-aluminium alloy, by duplicating an initial model. These crowns were then divided in two groups. Group 1 had twelve crowns with the aesthetic veneers made of ceromer (*Targis* – Ivoclar) and Group 2, veneers made of polyglass (*Artglass* – Heraeus Kulzer). All veneers had a previously calibrated undercut zone of 0,25mm. A cobalt-chromium clasp was made for each crown by a conventional technique and the retentive arms were located over the aesthetic veneers, with the final third on the undercut zone.

The crowns and clasps were then installed individually in a device previously designed<sup>14</sup> to insert and remove the clasps over the crowns (Figure 1). Basically, this equipment is composed by a dynamometer, a cycle counter and a modified sewing machine. The clasp was attached to the ne-

edle column of the sewing machine and the crown was attached to a proper site created in the basis of the machine. The crown was then linked to the dynamometer by a thick steel wire, allowing to measure the force necessary to have the dislodgement between clasp and crown.

With the machine action, the clasp was inserted and removed over the crown controlled by the cycle counter. For each insertion and removal, the cycle counter counted one cycle. In this manner, all crowns and respective clasps were submitted to a total of 5000 cycles (a period of approximately 4.5 years of wearing the dentures, considering 3 daily removals).

The force necessary to remove the clasp over the crown was measured before and during the test; after each hundred cycles before the 2000th cycle and after each two hundred cycles between the 2000th and the 5000th cycles.

All veneers were macroscopically inspected after the end of the test, in order to identify possible abrasion.

## RESULTS

The presentation of the force necessary to remove the clasps over the crowns during the test is shown in Tables 1 and 2.

It could be noted that the force necessary to remove the clasp over the crown did not have a significant variation along the test. However, after visual inspection, all crowns showed abrasion on the area of action of the final third of the retentive arm.

## DISCUSSION

The use of polyglass and ceromer technologies to make fixed bridges or crowns is increasing<sup>7,12</sup>, because of their adequate physical and aesthetic properties. In many cases, it is necessary to use fixed bridges or crowns conjugated to removable partial denture. However, there are no articles in the dental literature about the behaviour of these materials when submitted to removable partial denture placement and removal.

The present study was done in order to verify the behaviour of the aesthetic veneers made of se-

cond generation laboratorial composite resins (polyglass and ceromer) when submitted to the insertion and removal of circumferential cobalt-chromium clasps.

The force necessary to remove the clasp over the crowns was the parameter used to verify if a possible modification of the retention by the wear of the veneers occurs. If a significant wear occurs, the retention is diminished and the force tends to decrease.

There are, however, another factors that determine the flexibility of the retentive arm and, thus, the force necessary to remove the clasps over the crowns. The mechanical properties of the alloy used, length of clasp, curvature, cross sectional dimensions and taper of the clasp from the root to the tip are some of them<sup>1,3,22,23</sup>. The amount of undercut present on the teeth and the presence of an adequate reciprocity are also important<sup>2,19</sup>.

By the use of crowns made from an initial model, many of these factors were standardised in the present study. However, because the clasps were hand made, other important factors as the curvature, length, cross sectional dimensions and taper of clasps, were not so controlled. That is the cause of the initial variation of the forces among the test specimens in the Tables 1 and 2. Although these variations are not desirable, they are not so important, since this study aimed to investigate the possible variations of the force *during* the test.

The variations of the forces that occur during the test did not show a tendency to decrease or increase. These variations are due to the manual starting of the machine when it was necessary to measure the force. If the movement was faster, the force necessary to remove the clasp was lower than if the movement was slower. So, one can conclude that the force did not vary significantly during the test, allowing to say that the retention force stayed stable.

Many authors<sup>6,11,15,16,21,24</sup> compared the properties of polyglass and ceromer with the properties of ceramic and also with the enamel. These resins are used as a substitute for ceramic in many cases, and they are supposed to have an abrasion similar to enamel.

In relation to the action of removable partial denture clasps, however, the results obtained by

other authors<sup>8,17</sup> studying the clasp placement and removal over natural teeth showed no visual abrasion. Although the methodology of these studies were different of that used in the present paper, do not permitting a direct comparison of numbers, it is possible to observe that the abrasion of enamel is lower.

The same could be said for ceramic. The results of a study<sup>13</sup> showed that the ceramic do not present abrasion by insertion and removal of clasps.

So, it is possible to observe that enamel and ceramic showed better results compared with polyglass and ceromer when submitted to insertion and removal of RPD clasps. However, the clinical use of polyglass and ceromer veneers could be an alternative to be considered in the treatment planning, since in a simulated period of 4 \_ years of use, the force necessary to remove the clasp stayed stable, although wear could be ob-

served in the area of action of the final third of the retentive arm.

## CONCLUSIONS

The study carried as showed allowed to the following conclusions:

- a) veneers made by polyglass and ceromer suffered abrasion by cobalt-chromium clasps insertion and removal and
- b) this abrasion did not influence significantly the force necessary to remove the clasp over the crowns during these experiment.

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