Metal Polymer Interfaces-Assessment in Dentistry

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The purpose of this study was to analyze the behaviour of metal-polymer fixed partial prosthetic restorations when a factor of stress acts on them. There were analyzed 25 metal-polymer fixed partial dentures with the metallic component represented by a Co-Cr alloy. To achieve the samples, were followed the laboratory steps: metal infra-structure was made from Co-Cr alloy, the veneers, were made by using a Nexco kit (Ivoclar, Vivadent). Samples were tested by using the universal testing machine Multitest 5-I. After the test were made, the results showed that this type of restoration passed the requirements of ISO 10477 (> 5 MPa) of bonding Co-Cr, this alloy being accepted and indicated in practice by the dentists. Further studies will be conducted on the components of other types of metal-polymer fixed prosthetic restorations and beyond, and will emphasis and contribute to understanding the behaviour of materials to various factors, both laboratory and stress present in the oral cavity.

Key words: metal-polymer, restoration, bonding

Compared with the beginnings of dentistry, when the accent was on the mechanical properties and the resistance of the material, nowadays, the aesthetic plays a very important role. The question was raised on creating a prosthetic restoration to match the aesthetic. To meet this requirement, there were studied metal-polymer fixed partial prosthetic restorations.

In restorative dentistry the main purpose is to use materials with a range of biological characteristics, biomechanical and biosecurity, as efficient as possible.

Metal-acrylic and metal-polymer crowns are some of the most used restorations to reestablish the esthetic and the integrity of heavily destroyed teeth [1]. This type of restorations offers good aesthetic, low cost and good adaptation. New polymeric materials are enforced with ceramic particles which rise the quality and durability in time.

The replacement of noble alloys as AuPt with other materials more cheaply has resulted in the appearance on the market of dental alloys as Co-Cr system [2-5].

It was noted that between this material and the polymer there is needed a macro-mechanical adhesion, in order to maintain the polymer on the surface of the metallic frame.

Mixed metal-polymer crowns (metal-acrylic, metal-diacrylic) have the disadvantage of changing colour and physiognomy after 3-5 years, but also, the dislocation of the aesthetic veneer.

Several studies have shown that polymer crowns produce a lower abrasion if antagonists are natural teeth. If the antagonist is a ceramic restauration the result will be the abrasion of the polymer restauration.

The importance of understanding the characteristics of these types of materials underlies the success of making a fixed metal-polymer partial denture to match the needs and requirements both of the patient and the dentist.

Among the features of metal-polymer mixed restorations there can be mentioned: satisfactory aesthetic results, although, due to porosity, the color of the composite is not stable over time. The combination of the aesthetic and the metallic component (which gives very good mechanical properties) is a success in terms of the cost of the restoration.

Also, is important to be mentioned that in this case of restauration it is necessary to make a non-biological and invasive preparation, endodontic treatment and reductions of dental tissue (on the vestibular areas), compared to ceramic crowns. The level of retention is low due to the shape of the abutment; dehiscence and infiltration occur in the metal-polymer interface, causing changes, the fracture of the aesthetic component and the separation between the two components, if occlusal stress is present.

Despite competition that exists between ceramic prosthetic restorations and fixed partial dentures, the last ones are still among the most common aesthetic restorative materials.

Experimental part

The present *in vitro* study carried out for investigation of shear bond strength of metal-polymeric fix partial dentures. Twenty five specimens were tested in the universal testing machine, MultiTest 5-i. Twenty five Cobalt-Chrome metallic discs with a diameter of 8 mm and thickness of 2.5 mm were obtained by pouring/casting classical method. The discs patterns were cut in red wax foil with a thickness of 2.5 mm. On the surface of wax was attached micro-retention. The investment material Bellavest SH (Bego) was prepared in vacuum mixing device, (Model S/N) voltage watts Hz, poured into the investment ring. The assembly was preheated at a temperature of 900^0 C for 1 hour and 40 min. After this stage the wax was removed from the cast and investment material by burning the wax at the already mentioned temperature. The Co-Cr alloy is melted by the induction method in the Orcacast M device and is poured in the cast. The cooling process of the poured piece is slow because it must be avoided of the risk of high contraction and deformation of the poured metallic specimen. The specimen is removed from the investment material after complete cooling. The residual investment material is removed through sandblasting with ZnO particles 100 μm,

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Fig.1. Nexco kit (Ivoclar, Vivadent)- primer, opaquer and composite resin

at a pressure of 6 bar with TISSI DENTAL sandblasting device. The attached pouring bars are removed and the sample is polished with dedicated burs.

The next step was the veneering of the metallic discs with Nexco kit (Ivoclar, Vivadent) (fig.1). On the tested metallic surface is applied the primer (Link, Ivoclar, Vivadent). After the primer is dried, the opaque is applied in two-three layers until the micro-retentions are fully covers. Each layer of opaque is light cured for seven minutes. On the surface is applied an isolated metallic ring with a diameter of 4 mm. The first dentin layer (Nexco, Ivoclar Vivadent) of 0.2 mm, is inserted in the ring and condensed with dedicated instruments. The first layer of dentin is applied over the opaque and is light cured for 10 min with light-curing lamp Spectramat (Ivoclar). The next A2 dentin layers were light cured in the same conditions.

The discs were cast into self-curing acrylic mass. For the acrylic support was used a plastic round shape ring with a diameter of 15mm. The self-curing acrylic resin Duracryl Plus (Spofa) was poured into the plastic round shape trim and the metallic disc was positioned in the resin. The surface of metallic disc and polymeric cylinder were not covered by the acrylic resin. The entire thickness of the metallic disc was included in the self-curing resin. After setting of acrylic resin, the surface of the assembly was polished with a grinding machine by the wet-grinding process. The specimens were ultrasonically cleaned for 10 min with acetone and dried for 24 h.

The polymeric resin was trimmed with a trephine burr with a 4mm internal diameter. The polymeric resin was cylindrically shaped with the trephine burr. The angle made by metallic disc and polymeric resin was a 90° angle, ideal of the shear bond strength. The 90° angle made by polymeric cylinder and metallic disc perfectly guide the force on the metal-polymeric interface (fig. 2).

All the specimens were tested with the universal testing machine MultiTest 5-I (fig.3) at cross head speed of 1.0mm/min. Each specimen was seated and secured in the shear test jig. The loading and failure diagrams were registered and displayed by the additional computer and dedicate program.

Fig. 2. The preparation of composite cylinder and Co-Cr disc

Fig. 3. Universal testing machine MultiTest 5-I.

Results and discussions

After testing the adhesion between metal and polymer, the results were merged in a data base and analysed.

All tested bonding systems passed the requirements of ISO 10477 (>5 MPa) for bonding Co-Cr alloy. These results were confirmed by the ANOVA test.

After analysing the materials, the results showed that adhesion between metal and polymer is in the normal limits, this type of mixt denture being indicated and well accepted in practice.

The mean (standard deviations) of shear bond strength of Co-Cr alloy ranged from 16.44 MPa (1.42) to 17.70 Mpa (1.66).

The bond strength values for the Co-Cr alloys, bonding systems, are summarized in table 1. The average was about 16.82, but there were higher and lower values, between 14.74 MPa and 19.13 MPa.

Manufacturers are continuously developing and selling new materials. For dental practitioners, choosing a material has become a difficult decision. The management and promotion of the great producers in the domain of dental materials is guiding the decision of practitioners. The decision of the practitioners tends to be based on commercials and promotion of the products not on the scientifically proves.

The improvement of composite with inorganic fillers, like ceramic particles (Nexco, Ivoclar, Vivadent) is

Sample number	Force Value (MPa)
1.	15.92
2.	16.38
3.	16.01
4.	19.13
5.	14.74
6.	17.20
7.	16.17
8.	16.86
9.	17.03
10.	18.47
11.	16.32
12.	16.88
13.	15.19
14.	16.45
15.	16.91
16.	16.33
17.	16.65
18.	16.52
19.	17.52
20.	16.24
21.	17.67
22.	18.12
23.	17.61
24.	17.38
25.	16.92

Table 1
THE BOND STRENGTH VALUES

improving the standards of polymeric materials and is extending their application in practice. The mechanical resistance, aesthetics and abrasion resistance are improved and increase the durability in time. Shear bond strength between two different materials is influenced by the different factors like: preparation of substrate which should be polished virtually 100% and parallel to the level of the testing device and perpendicular to the composite cylinder. This is one of the ideal conditions for shear bond tests.

The future studies intend to test the shear bond stress between conditioned Co-Cr alloy after different protocols and other types of composites with ceramic particles. There were made several studies that analysed the differences between Co-Cr alloy and cp-Ti.

The results revealed no significant differences between cp-Ti and Co-Cr alloy ($p>0.05$).

The mean (standard deviation) of shear bond strength of cp Ti ranged from 16.44 MPa (1.42) to 17.07 MPa (1.69) [6, 7].

Even the similarities between the materials, it depends of what the patient wants. The doctor has to explain all the advantages and disadvantages of the material, so the patient will take the good decision.

Conclusions

After analysing the materials, the results showed that the adhesion between metal and polymer is in the normal limits, this type of mixt denture being indicated and well accepted in practice.

The shear bond strength of Nexco composite had registered results that correspond to the standards, which means it is appropriate to be used in practice.

In the future, dentists and scientists working in the field of dental materials, especially on dental materials and prosthetics, must reduce the lack of evidence for better treatment given to individual patient care.

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