Comparative and Non-invasive Study of Two Different Ceramic Materials

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The purpose of this study is to investigate through imagistic methods repaired metal ceramic crowns with ceramic material. Fracture of ceramic veneer may be reconstructed with either ceramic or composite resin material. The interfaces resulted are the key of success for the longevity of these metal-ceramic repaired crowns. 20 metal ceramic crowns which restore the upper first incisor were made from Ni-Cr alloy and Kiss (D.Sign) ceramic material. A defect of 3x3 mm was made on the buccal face of each crown. The samples were divided in two groups. Each group was repaired with a different ceramic mass. Group one was repaired with In Line ceramic (Ivoclar Vivadent) and group 2 was repaired with VMK ceramic (Vita).Reparation of the crowns generated new interfaces between different materials. The interfaces were imagistic and non-invasive investigate by X-ray and Optical Coherence Tomography. The quality of the interfaces could be evaluated and also some clinical conclusions about the materials could be obtained.

Keywords: metal-ceramic crown, fracture, repaired, imagistic investigation, non-invazive

Metal ceramic crowns proved their high qualities more than 40 years. This type of fixed partial prostheses has excellent esthetics, mechanical resistance, bio-compatibility, good marginal adaptation, and color stability. Once ceramic materials were introduced in dentistry, a great progress took place. Metal- ceramic fixed partial prosthesis reconstruct tooth with crown destruction can reestablish the partial edentate's aches. Ceramic materials are also used in implantlogy and periodontology [1, 2]. One of the disadvantages is that ceramic mass is suitable to fracture. In case of traumatic occlusion, defects that may appear during technological stages, an incorrect treatment plan, cement wash or accidents, ceramic veneer may be fractured [3-5]. Even minor fissures in the ceramic mass which are not detected by simple eye inspection may generate crakes and fracture of the ceramic veneer. In some particular cases, the replacement of fixed partial prosthesis may not be necessary and the fixed partial prosthesis can be repaired through direct methods (composite resin) or in dental laboratory (ceramic mass). Metal-ceramic fixed partial prosthesis was carefully studied along the years and researches continue to study and improve the qualities of this material [6, 7].

Experimental part

Material and Method

The samples involved in this study are metal-ceramic crowns. All 20 metal-ceramic crowns restore the upper first incisor 2.1. In order to obtain identical probes, the working cast was duplicated for 20 times. The samples were made through classic technique of melting and pouring. Metal-ceramic crowns are composed by metallic infrastructure and ceramic veneer. Metallic infrastructure was made from Ni-Cr alloy and for the veneer it was used Kiss (D.Sign) ceramic. In order to simulate the fracture of the veneer, the ceramic mass was removed from the buccal face of the crown and the incisal margin. Size defect is 3x3mm. The ceramic material was removed with a diamonded instrument with no pressure and under air-water cooling in order to avoid additional fissures and fractures of the ceramic mass. Also the opaque layer was removed until the metallic infrastructure was exposed (fig.1).

Before starting the reparation procedure, the metallic infrastructure and standing ceramic mass, have to be conditioned. Conditioning method involved sandblasting of both metallic and ceramic surface. The samples were sandblasted with particles of Al_2O_3 which have 50 μm in diameter. After conditioning, both surfaces become rough and this character of the surfaces improves the adhesion of the repair material (fig.2). Sandblasting was made to all the samples, at a pressure of 3 Barr from a distance of 10cm. Next stage in reparation process was the lay-down of the opaque. Two types of different ceramics were used for reparation of the samples. Metal ceramic crowns were divided in two groups, each group containing 10 samples. Group 1 was repaired with In Line ceramic (Ivoclar

Fig.1. Defect on the buccal face of metal-ceramic crown

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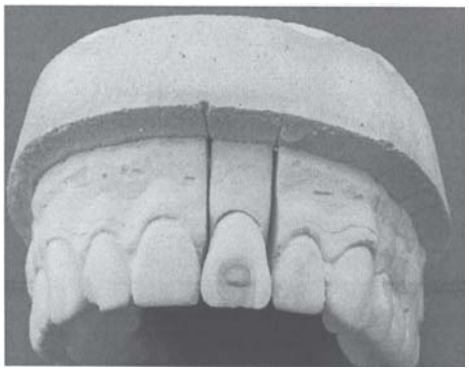

Fig.2. Conditioned sample- sandblasted with Al_2O_3 at a pressure of 3 Barr

Vivadent) and group 2 was repaired with VMK ceramic (Vita). Opaque material, which has to lay down only on the metallic interface just for isolating the infrastructure from the ceramic mass. Otherwise, metallic infrastructure will transpire through ceramic veneer and will compromise the restoration esthetics. The opaque of In Line Ceramic (Ivoclar Vivadent) has its own opaque material, designed by the producer as a mono-component material. The opaque paste has the disadvantage that may not completely isolate the metallic infrastructure and it is possible to transpire through the ceramic veneer. The opaque designed for VMK Master (Vita) ceramic is a bi-component material, powder-liquid. The opaque material designed by Vita for VMK Master is a powder-liquid material and can be laid down in a few layers and will not transpire through ceramic mass. Both opaque materials need about 5 min to dry and only then the ceramic mass can be laid down. The first ceramic layer is the dentin. This layer also reconstructs the morphologic character of the first central upper incisor. Ceramic is burned at the temperature with 20^0C less in comparison with the temperature indicated by the producer. The last layer is the translucent ceramic, laid down into a thin layer and also burned in the ceramic oven (fig.3).

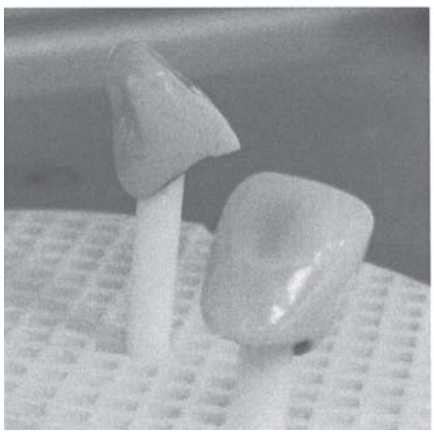

Fig.3. Repaired metal-ceramic crowns

Group 1 and group 2 were investigated through both imagistic methods- X-rays and Optical Coherence Tomography. X-rays gives information about macro-defects in comparison with Optical Coherence Tomography which gives information about micro-defects. X-ray is a conventional imagistic investigation method which can register only metals and radio-opaque materials. With Optical Coherence Tomography's help, a revolutionary and new investigation technique solid materials and soft tissue can be scanned. OCT offers images materials surface and the interior of materials. The wave can penetrate the material and 3D reconstructions can be made. So, from OCT are received information about the deep layers of the reconstruction, and the ceramic-ceramic interface. The quality interface can be evaluated with great accuracy.

Results and Conclusions

First, both groups were X-ray investigated. After analyzing the images, some macro-defects could be identified (fig.4). The metallic infrastructure of one sample from group 2 was damaged during the removing of the opaque layer. At 3 samples the integrity of the reparation was not perfect. Lack of material could be observed from the profile images. Also incise margin was not perfectly reconstructed.

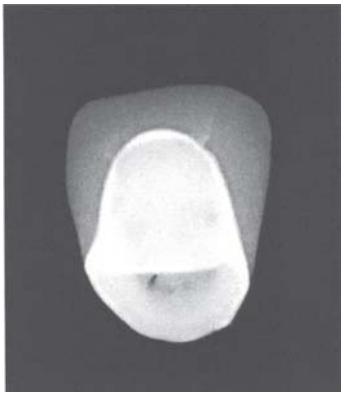

Fig.4. X-ray- infrastructure defect

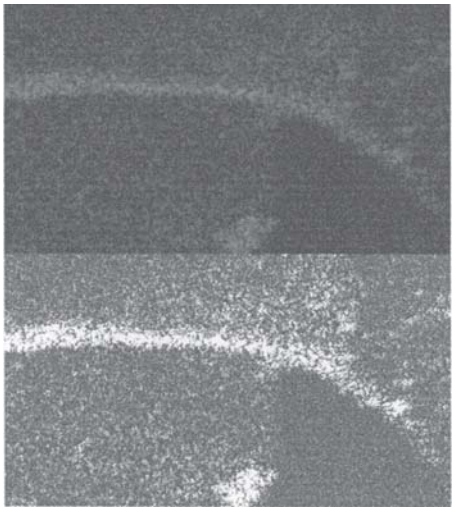

Fig.5. Opaque layer infiltrated between ceramic materials

Optical Coherence Tomography which is an accurate imagistic investigation method identified defects located into the deep layers of the interface and ceramic material used for reparation. The defects were identified as gaps, porosities inside the reparation ceramic material. At one sample (fig.5) was identified opaque material infiltrated between the two ceramic layers (Kiss and In Line ceramic). Also interfaces surfaces were not neat (fig.6). All the samples from both groups were scanned in two axes: mesio-distal transversal plan and cervical –incise plan. After analyzing the images of the two groups, no significant differences were detected. In Line ceramic and VMK ceramic emphasized similar defects. Also the practitioner's work and attention are important. So the results of the two ceramic materials involved in this study were almost the same. Further investigations need to be done in order to establish if there are important differences about the quality of the two ceramic materials.

All these macro and micro-defects are compromising the quality and longevity of the reparation and metal-

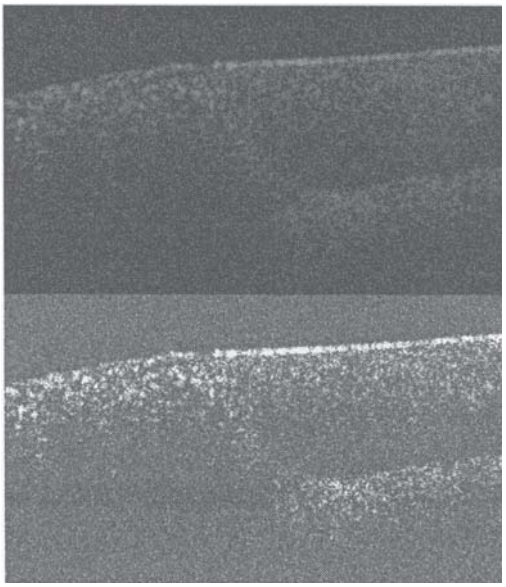

Fig.6. Incise view of the ceramic reconstruction

ceramic crown. The defects lead to marginal micro-infiltration, fissures in case of overloaded traumatic occlusion. Coloration of the repaired crown, propagation of fissures and cracks are other risks which may lead to failure of the reparation. Also the infiltration on the opaque material between the two ceramic layers must be mentioned. This infiltration may be a starting point for the degeneration of the repaired metal-ceramic crown.

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