Qualitative study of repaired metal ceramic crowns

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Abstract: - The purpose of this study is to investigate the reparation of metal ceramic crowns with ceramic mass. 30 metal ceramic crowns which restore the upper first central incisor (2.1) were divided in three groups. Each group was repaired with a different ceramic material. Group 1- In Line (Ivoclar Vivadent) ceramic, the second group was repaired with D.Sign (Ivoclar Vivadent) and for the last group was used VMK.Master (Vita). All the repaired crowns were investigated through imagistic non-invasive methods. The metallic infrastructure of the samples was made from Ni-Cr alloy and the porcelain mass was Kiss (D.Sign). Defects were made on the buccal surface of each crown. The ceramic mass and the opaque were removed and the metallic infrastructure was exposed. Size defects has 3x3mm and it is situated on incise and 1/3 medium buccal surface. The defect was made with a green grinding instrument under air-water cooling. All the samples were conditioned and repaired with ceramic mass. The reparations were investigated with two noninvasive imagistic methods Rx and Optical Coherence Tomography Time Domain in order to detect de reparation’s defects. The investigation methods may spot the presence or absence defects localized at the interface between the two materials and those localized in the ceramic mass.

Key-Words: - metal ceramic crown, defect, reparation, ceramic mass, non-invasive investigation, imagistic investigation

1 Introduction
We can consider that metal ceramic crowns have a long history in dentistry and have proven during 40 years their qualities and represent the result of the progresses made in dentistry. Metal ceramic prosthesis were tested and studied and despite of all these tests, proved their superior qualities and were considered the best option for restoring partial edematous arches. Metal-ceramic crowns respect three important principles: esthetics, functional-oclusal and mechanical resistance.
Metal-ceramic crowns have a metallic infrastructure which can be made through different techniques: pouring, galvanization and sintering and grinding-CAD/CAM. Despite of the new techniques developed for making the metallic infrastructure, the pouring method is best choice. Metallic infrastructure may be made through different techniques from noble, non noble alloys and titan through. The metallic component cover the dental abutment, protect the cervical limit of the abutment, delimitate the physiognomic component, assure the morphology of occlusal surface and incises margins, sustain the ceramic mass, assure the infrastructure’s stability and respect the physiognomic requests. The longevity of metal-ceramic systems, specifically the integrity of the veneering porcelain layer depends by the framework’s design. For increasing the long term prognosis of the porcelain veneer two practitioners can apply one of the two principles: (1) the porcelain is veneered with the minimum thickness compatible with good esthetics, and (2) the porcelain is supported by the coping so that the tensile or shear fractures can be minimized. An excessively thick porcelain layer may be more liable to shear and tensile force that may generate fractures under occlusal loading. The technology of performing metal-ceramic crowns or fixed partial dentures is involving many stages which can lead to errors and failure of the restoration. Such errors are represented by the lack of adaptation of metallic infrastructure, porosities and extra material on the surface of metallic infrastructure, absence of metallic material in the cervical area, precarious adaptation of metallic infrastructure, porosities in ceramic mass, fissure and fractures on the surface or into the deep layers of ceramic mass. Detaching of
ceramic mass may also take place from different causes.

Studies spotted that fracture of porcelain mass is the second most common cause metal-ceramic crowns and fixed partial dentures replacement. Some studies showed that porcelain fracture occur in 2.5% to 4.5% of single metal ceramic crowns and 2% of fixed partial dentures. Other studies reported that structural problems of metal ceramic prostheses can be as low as 3% to 4% in 10 years service period.

Fracture of the ceramic mass may be rehabilitated through replacement of the fixed partial prosthesis or the reparation with composite resin through direct technique, or ceramic material (if the denture is not cemented). These reparations may be a good solution and the esthetic results are satisfactory. The interfaces resulted after reparation may be a sensitive spot and need to be investigated. This study is proposing to investigate the interfaces resulted after reparation of 20 metal-ceramic crowns. The chosen investigation methods are non-invasive and imagistic methods – Optical Coherence Tomography and Rx. OCT Time Domain can scan not only the surface of the interface but also the deep layers of it and the micro-defects. Rx offers an image with macro-defects and defects on the surface of the reparation.

All ceramic systems started their history about 20 years ago and are competing with metal ceramic systems but up to now, long term studies could not prove that all ceramic systems have superior qualities in comparison with metal ceramic once.

2 Material and Method

The purpose of this study is the non-invasive, imagistic investigation of the reparation of 30 metal ceramic crowns. The samples were divided into three groups and each group was repaired with a different ceramic material. The first group was repaired with In Line (Ivoclar Vivadent) ceramic, the second group was repaired with D.Sign (Ivoclar Vivadent) and for the last group was used VMK.Master (Vita).

All the crowns restore the upper first incisor 2.1. The cast was duplicated 30 times, for each crown. The metallic infrastructure was made through the classic pouring technique from Ni-Cr alloy. The thickness of the metallic infrastructure had 0.3-0.4 mm. All metallic infrastructures had the same thickness and all of them were macroscopic inspected in order to detect porosities or metallic substance absence. The protocol for metal-ceramic technology was fully respected for all the samples. The ceramic mass Kiss (D.Sign) was applied over the opaque layer and the morphological characteristics of the first incisor were modeled before burning. The ceramic was burned at the temperature of 910° C. The next stage was the application of the translucence ceramic.

To simulate the fracture of the ceramic component, a defect was made to each metal ceramic crown on the buccal surface. The defect’s size was 3x3mm and it was situated in the 1/3 incise and 1/3 medium of the buccal surface. A diamonded grinding instrument was used with no pressure and under air-water cooling in order to avoid fractures and fissures into the outstanding ceramic mass.

The physiognomic component and the opaque layer were completely removed and metallic infrastructure was exposed. During this stage, the practitioner tried to maintain the incise margin. Despite the effort, at some samples it was not possible to conserve part of the incise margin due to crackly character of porcelain and the thickness of the incise margin which is not sustained by the metallic infrastructure.

Before applying the opaque, the metallic infrastructure and the residual ceramic mass were sandblasted with particles of Al₂O₃-50μm at a pressure of 3 Barr. The mechanical retention of metallic infrastructure and ceramic mass is improved by sandblasting.
designed for In Line (Ivoclar, Vivadent) and D.Sign (Ivoclar, Vivadent) ceramics is presented as mono-component material paste. The opaque designed for VMK. Master (Vita) ceramic is a bi-component material, powder-liquid. The disadvantages for the first two groups are that the opaque material may transpire through ceramic mass. 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.

After sandblasting, the opaque is applied with a paste-brush just on the metallic infrastructure. The drying process takes about 5 minutes and only then, ceramic material may be laid-down and reconstruct the defect. The first layer was the dentin layer. The colors were chosen in such manner to obtain a physiognomic effect. For each group the ceramic was burned at a temperature with 20°C less than the burning temperature because the purpose is to correct the veneer of a metal-ceramic crown not to make one. So for the first group the burning temperature was 910°C, for the second group the burning temperature was 880°C and for the last group the temperature was 930°C. Last stage of the reparation process was the laying-down of the translucence ceramic.

3 Problem Solution

Though the aesthetic aspect of the repaired metal-ceramic material is not the issue of this study, it is important to mention that the opaque presented as a bi-component material, liquid-powder assured the best physiognomic aspect of the reparations. Optical Coherence Tomography is part of the new generation of technology which can generate cross-sectional images without destroying the samples. OCT can scan biologic and non-biologic materials and can be used. The samples were scanned in two axes: mesio-distal and incise-cervical. The interest areas were represented by the surface and deep layers of the ceramic-ceramic interface. Each group was imagistic investigated on both axes. Optical Coherence Tomography- Time Domain system worked in B-scan mode along the interfaces to be studied while the C-scan mode was only used at the defect areas. Optical Coherence tomography may describe and identify surface roughness, volume loss, material thickness and can scan materials up to 1mm deep. X ray can give images related only to macro-defects and lack of substance which cannot always be detected by eye inspection. Group 1, repaired with In Line (Ivoclar Vivadent) ceramic material was OCT and Rx investigates.

All ceramic crowns repaired with three different ceramic materials (In Line -Ivoclar Vivadent, D.Sign -Ivoclar Vivadent, and VMK.Master -Vita) were imagistic investigated. Both systems-Rx and OCT are non-invasive imagistic investigations. The chosen investigation methods gives the possibility to evaluate the quality of repaired metal-ceramic crowns with ought damaging the samples and to spot the vulnerable areas of the ceramic-ceramic interface.
Fig. 7 X-ray image of metal-ceramic crown repaired with In Line-Ivoclar Vivadent ceramic; material defect of metallic infrastructure.

Fig. 8 OCT image (C scann mode) a gap detected in ceramic mass (D.Sign -Ivoclar Vivadent).

Fig. 9 X-ray image of metal ceramic crown repaired with D.Sign -Ivoclar Vivadent- infiltration of the opaque layer between the ceramic layers.

Fig. 11 OCT image (B scann mode) of metal-ceramic crown repaired with VMK Master-Vita.

Fig. 12 X-ray image of metal-ceramic crown repaired with VMK Master-Vita- apparently a perfect aspect of the reparation.

Optical Coherence Tomography scanning emphasized material defects, gaps, irregular surface of the interface and porosities at all the samples. To some samples it was identified lack of marginal adaptation between the two ceramic masses and the defects were evident into the superficial and deep layers of the interfaces. X-rays imagistic investigation showed that reparation of some samples has apparently a perfect aspect and no defects. But these results were confirmed by Optical Tomography investigation.
4 Conclusions

Interface macro and micro defects can lead to fracture of the reparation and colour instability because of marginal infiltration.

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