Non-invasive Imagistic Investigations of repaired IPS Empress e.max all ceramic crowns

PETRESCU EMANUELA, NEGRUTIU MEDA LAVINIA, SINESCU COSMIN, ROMINU ROXANA, TOPALA FLORIN, ROMINU MIHAI, PODOLEANU ADRIAN GH.
Department of Prophylactics and Dental Materials
University of Medicine and Pharmacy Victor Babes
B-dul Revolutiei, Nr. 9, Timisoara
ROMANIA
emanuelapetrescu@yahoo.com

Abstract: -The present study is proposing to investigate through non-invasive techniques, the quality of repaired of all-ceramic crowns with ceramic material. 20 all-ceramic crowns made with IPS e.max Empress System. The ceramic component was removed with a grinding instrument from the buccal-incisal of each crown. The ceramic veneer was removed in order to simulate the fracture of the ceramic supra-structure. Defect’s size was approximately 3x3mm for all the specimens. In some cases the incisal margin was also removed. All the crowns were repaired with ceramic material VM7 (Vita) after the manufacturer’s instructions. The repaired area was investigated through imagistic and also non-invasive techniques. The involved investigation systems are analyzing macroscopic and microscopic the repaired area. Optical Coherence Tomography Time Domain and X ray. Optical Coherence Tomography is an optical microscope which can scan the surface and deep layers of the investigated interface. X ray is useful in detecting macroscopic defects and gaps into the material mass. The quality of the repaired defects may be evaluated and some clinical indications can be made.

Key-Words: - all ceramic, crown, fracture, reparation, imagistic, Optical Coherence Tomography, X ray

1 Introduction
All-ceramic fixed partial prosthesis are the best choice for excellent aesthetics. Nowadays, the patients have high expectations about quality and aesthetics. All ceramic fixed systems appeared almost 30 years ago and along this time, they were constantly improved and developed. Ceramic systems gained there’s place not only in prosthetics but also in implantology, periodontology and orthodontics. At present all-ceramic systems are representing an alternative for metal-ceramic fixed partial prosthesis. All-ceramic inlays, onlays, veneers and crowns can restore teeth with extended destructions and which must be reconstructed and conserved. All ceramic fixed partial prosthesis can also assure the integrity of partial edentulous arches. Ceramic cores of new ceramic systems are now reinforced through dispersion with leucite, glass infiltration into sintered alumina (Al₂O₃), high-purity alumina or zirconium dioxide (Zirconia, ZrO₂). All ceramic fixed partial prosthesis may be performed through different techniques, such as heat pressed ceramic IPS Empress, grinding of ceramic blocs etc. These types of prosthesis put out the metallic infrastructure which can bright at the cervical area or may tattoo the cervical gum and affect the aesthetic aspect. Despite of it’s elasticity, proper for sharing occlusal tensions, metallic infrastructure is replaced by ceramic core made through heat pressing or grinding procedure. Ceramic layers are layered and burned over the ceramic core
Despite of excellent aesthetics, all ceramic fixed partial prosthesis has a few sensitive properties. One of them is the fracture of ceramic veneer or ceramic core. This phenomenon takes place because ceramic masses have no elasticity and are breakage. Occlusal overloading, defects into the ceramic mass which appear during technological process and were not detected, fissure which may generate the fracture of the ceramic veneer and cement wash in case of an incorrect marginal adaptation which lead to absence of stability and adhesion of the all ceramic crow. These are a few reasons for which an all ceramic crowns can fail.

2 Material and Method
This study involves 20 all ceramic crowns made through IPS Empress e.max technique. All crowns restore the upper first incisor. The abutment was prepared with a grinding instrument on a plaster
pattern. After this first step, an impression was taken of the patterns and also of the prepared abutment. After impressing another pattern was poured and the working cast was obtained. The wax-pattern of ceramic core was adapted to the prepared abutment and had 0.4mm thickness. After attaching the draw bar to the wax-patterns the kit was rid of tension. Drawbars had 3mm in diameter and 2 mm length. The attached wax-patterns and draw-bar were with Alox Plunger positioned on the injection cone with the help of a special device. The device indicates an angle of 45-60º between the injection cone and wax-pattern. The assembly wax-pattern-draw Barr must be fixed and make an angle of 45-60º with the injection cone, for a proper flowing of heated ceramic. If this position is not respected the heated pressed ceramic may not fully complete the wax pattern. In his case the ceramic core is not altogether and may present gaps and air inclusions. The investment material (Press Vest Speed) was prepared following the manufacturer’s instructions. The kit (wax-pattern, draw bar and pressing plunger) was invested using a proper ring. The ring was removed after the setting of Press Vest Speed material. The kit was introduced in the preheating oven Sirio - Fire Light for 60 minutes at 850ºC. The wax was evacuated and the cast was obtained. The injection plunger was isolated Separator. After isolating the injection plunger, ceramic cylinder e.max.press was introduced in the injection cone. The pre-set parameters of the injection program rules at 920ºC. At this temperature the ceramic core is fused and pressed into the cast. The pre-heated cast was introduced in the oven and the proper injection process took place. After ending the injection process and slow cooling, the kit was de-invested with low force. The residual investment material was removed by sand-blasting with particles of Al₂O₃ and 50µm in diameter at a pressure of 2 Barr. Buccal face and the created defect area were sand-blasted. These surfaces become matte. The ceramic used for the reparation was VM7 (Vita) the only ceramic mass compatible for reparation of all-ceramic systems. The VM7 ceramic mass was applied on the defect into thin layers. The first laid layer was the dentin. The ceramic was morphological modelled and then burned into the Programat EP 5000 (Ivoclar) oven. The burning process took place at a temperature of 930ºC. In case of reparation of all ceramic systems, the burning temperature has to be with 20ºC less than the temperature at which the ceramic mass are first burned. The translucence ceramic reconstruct the incise margin and the burning process takes place at 910°C. The oven has programs for each procedure. The last layer is the glaze/varnish. It is the applied into a thin layer and then burned at the 890ºC temperature. The reparation procedure is ending with the burning stage of the ceramic varnish. All the samples were imagistic investigated through non-invasive technologies. Optical Coherence Tomography is a revolutionary, imaging and non-invasive technique which has been developed for generating cross-sectional imaging in biologic and non-biologic material. OCT is finding his applicability in dentistry as a diagnostic tool. It may be used for diagnosing early decay, decay hidden under enamel, filling defects or defects present into the fixed partial prosthesis or dentures. It finds its applicability even in implantology, investigations of temporal-mandible joint and occlusion investigations. Optical Coherence Tomography is actually a signal acquisition and processing method because captures micro-metric resolution and has the capability to reconstruct three-dimensional images of the scanned sample. It is using infrared light and the use relatively long wavelength light allows it to penetrate into the scattering medium. Depending on the light source’s properties, OCT has achieved nano-metric resolution. (~100 nm). This revolutionary technique can obtain high resolution images of biological tissue (ex.-retina) and non-biological materials. OCT can detect the material thickness, surface roughness characterization, surface and cross-section imaging, volume loss. This technology offers the access and has the skill to scan interiors of hard-to-reach spaces.
X rays are a conventional medical investigation method which can reproduce images of biological solid tissues and only radio-opaque materials. Both methods are investigating the quality of the reparation of all-ceramic crowns. The interfaces integrity, air inclusions, fissures into the ceramic mass can be revealed.

3 Discussions
All-ceramic crowns were scanned by Optical Coherence Tomography on lateral (mesio-distal) and vertical (buccal-oral) and cervical-incisal axis. All the investigated specimens emphasized defect along the interfaces. The defects were represented by gaps, air inclusions, irregularities and discontinuities of the interfaces. Also in some cases, were identified the absences of marginal adaptation which can lead to marginal coloration or fracture of the reparation. All these defects may lead to failure of the reparation of all ceramic crowns especially if the patient suffers of occlusal overloading and bruxism.
4 Conclusion
All the investigated specimens presented smaller or larger defects. The identified defects were represented by gaps as a result of air inclusions or insufficient adaptation of repairing ceramic. The interface between the two types of ceramic was not perfectly neat. Surface roughness could be observed and the absence of interface integrity into deep and superficial layers. Properties of ceramic materials may be improved as well the ceramic mass used for reparation. Through these non-invasive methods the quality of all ceramic crowns and not only can be verified. The sample can be evaluated without any damages. The technology is expensive at this moment but also very useful. Marginal adaptation all ceramic and metal-ceramic crowns may also be verified, before cementation. Microscopic cracks and fracture lines which are one of etiologic factors of all ceramic and metal-ceramic failures can also be identified. These methods are facing some of the sensitive spots of all-ceramic prosthesis and helps practitioners to identify these sensitive issues.

5 Acknowledgment:
I would like to acknowledge for the support of CNCSIS Research Project For Young Team 101/2010.

References:
X1. Meda L. Negrutiu, Cosmin Sinescu, Mihai Rominu, Michael Hughes, George Dobre, Adrian Gh. Podoleanu, Optical coherence tomography and confocal microscopy investigations of dental


X5 Meda Negruti; Cosmin Sinescu; Florin Topala; Mihai Rominu; Dubravka Markovic; Daniela Pop; Michael Hughes; Adrian Bradu; George Dobre; Adrian G. Podoleanu