Abstract: - The purpose of this in vitro study is to evaluate the quality of repaired all ceramic IPS Empress e.max crowns. Excellent esthetics of all ceramic crowns is well known. One disadvantage of all ceramic restoration is the susceptibility to fracture due to brittle character of ceramic materials. Fracture of ceramic veneer may be repaired with composite resin or special designed ceramic material. Twenty four all ceramic crowns were made with IPS Empress e.max system. Fracture of ceramic veneer happens in the cervical, incise or functional (occlusal) area of metal-ceramic and all ceramic crowns. For simulating the fracture of ceramic veneers, defects of 2x2cm were made with a grinding instrument in the 1/3 incise area, on facial surface of each crown. All defects were repaired with Filtek Supreme (3M ESPE) composite resin. Samples were imagistic investigated by Optical Computer Tomography- Time Domain and Scanning Electron Microscopy. The interested areas were ceramic-composite resin interfaces. Longevity of all repaired ceramic crowns depends on interfaces integrity. Apparently intact, the ceramic-composite resin interface may display microscopic material defects which may lead to failure. Optical Coherence Tomography and Scanning Electron Microscopy are identifying and validate the micro-defects.

Key-Words: - all ceramic crowns, reparation, composite resin, imagistic investigation, interface, OCT, SEM

1 Introduction

All ceramic materials begun there’s history in dentistry decades ago. Metal-ceramic and especially all-ceramic restorations are very attractive for patients and practitioners due to excellent esthetics. Ceramic materials conquered there’s place in prosthetics, implantology and orthodontics due to biocompatibility, mechanical strength and esthetics. All ceramic restorations are divided, after technological process in CAD-CAM system, Empress, In-Ceram and Procera system. CAD-CAM system is based on computer technology. CAD-CAM is capturing and storing electronically a photographic image of prepared dental abutment. CAD-CAM can design inlays, onlays or single-unit crowns with ought impression. After registering and processing the photographic image of the prepared tooth, software makes 3D reconstructions. The practitioner selects the proper features and making various decisions on the virtual model. Information is send to a local milling machine. With specially designed diamond burs the restoration is milled from a solid ingot of ceramic.

Ceramic ingots have pre-determined shades that match to teeth’s natural color. The milling process is quick and the patient can receive the restoration in the same day. Failure to loads of these restorations is very similar to those of natural teeth.

Procera AllCeram is a CAD-CAM based method which produces a crown by overlaying a very durable ceramic coping of either alumina or zirconia, referred to as a core, with Vitadur Alpha porcelain. Procera can be used to make crowns bridges and veneers.

In Ceram, designed by Vita, is a system that design all ceramic crowns and fixed partial dentures with a glass infiltrated aluminum oxide core material. In Ceram system can be recommended for anterior and posterior crowns as well as for anterior single-retainer fixed partial dentures.

Emprees system is using heat and pressure in order to obtain veneers, onlays, inlays, crowns and fixed partial prosthesis. The technique is similar to a lost-wax technique in that a hollow investment pattern is made. From now on, a specially designed pressure-injected leucite-reinforced ceramic is
pressed into the mold by using porcelain-oven and the ceramic core is obtained.

Ceramic materials evaluated along time and still know are improved. Brittle character of ceramic materials is still a disadvantage for metal-ceramic and all ceramic crowns. Replacement of restorations involves high costs, is time consuming and uncomfortable for patient. Practitioners and dental technicians have at their disposal two methods for repairing fractured ceramic veneers of metal-ceramic and all ceramic crowns. The first method is an indirect one which is using ceramics for reparation. In case of final cemented restorations, this reparation method is impossible to be used. Composite resin materials come into practitioners and patients help. These materials, offers he possibility to make direct and esthetic reparations in dental studio for final cemented inlays, onlays, veneers, all-ceramic and metal-ceramic crowns or fixed partial prosthesis.

2 Materials and Method

Twenty four single all ceramic IPS Empress crowns were involved in this in vitro study. IPS Empress system involves a ceramic core obtained by pressing plasticized ceramic. Ceramic core is made by wax-up technique on working cast. The wax pattern and working cast are then embedded into investment material and heated up to 850 °C for 60 minutes. At this temperature, the wax is burned and eliminated from the investment tray. The cast for the ceramic core is ready for the pressing stage. At this stage, the investment tray is ready to be put in the IPS Empress oven. Ceramic ingot is heated at 920 °C. At this temperature, ceramic ingots are plasticized and may be injected into the cast by the injection plunger. After ending the pressing program, the investment tray is slowly cooled. Ceramic core is released from the investment material by carefully sectioning the materials. Residual investment material from the ceramic core is removed by sand-blasting with 50µm, Al₂O₃ particles at a pressure of 2 Bar. Draw bar of each ceramic core is sectioned and finished with a cutter mill. IPS Empress e.max Ceram is laid on the ceramic core for obtaining excellent esthetics. Layering technique is proper to all ceramic crowns and assures individual morphological characteristics of the tooth that must be restored. Translucent e.max Ceram is laid down in layers of 0,3mm each and burned on ceramic core. Fracture of ceramic veneer was obtained by removing the laid ceramic with a diamond burr. Ceramic material from the 1/3 incise of facial surface was removed and ceramic core was exposed. Created defects of all the samples and facial surfaces were conditioned by sandblasting with alumina particles of 110µm under pressure of 3 bar for 13 seconds from a distance of 10mm. For improving adhesion of the composite resin to ceramic core, all the samples were treated with HF and silane. Ceramic core was conditioned with HF 10% for 90 seconds. The acid was washed for 20 seconds, and after drying the samples, silane (Monobond S) was laid for 120 seconds.

The reconstruction of created defect was made with Adapter Scotchbond 1 XT adhesive (3M ESPE) and Filtek Supreme (3M ESPE) composite resin. The adhesive was light-cure for 20 seconds and each composite resin layer was light-cured for 40 second. The composite resin reconstruction was adapted with finishing instruments.

Ceramic-composite resin interfaces were imagistic investigated by non-invasive Optical Coherence Tomography Time Domain and invasive Scanning Electron Microscopy. OCT is a non-invasive, high-resolution imagistic investigation method which is generating cross sectional images of biologic and non biologic material. In medicine, it is a diagnostic tool which captures micro-metric resolution and may 3D reconstruct the scanned images. OCT uses broad-band, near infrared light sources with considerable penetration into tissue. Microcomputer tomography imaged the material defects, marginal adaptation of the composite resin to the ceramic material and gaps present into the reparation material. Scanning Electron Microscopy is evidencing the surface of ceramic –composite interface which appears to be nonlinear. En Face OCT permits to visualize a more complex layered structure of the reparation and all ceramic-composite resin interface.

3 Results

Apparently linear and continuous interfaces, micro-defects were detected by SEM and micro OCT. These defects were identified as non-linear interfaces, gaps localized on the surface of the interface and in composite layers. Micro OCT was the first investigation method. Cross sectional images evidenced vicious marginal adaptation and micro-porosities between ceramic and composite materials. Also, not only the material’s surface evidenced defect, also the deep layers. All the samples emphasized defects localized into the reparation material and into all samples interface’s layers.
Fig. 1 SEM image-nonlinear interface with micro-gap

Fig. 2 SEM investigation- gaps and composite resin particles on ceramic material

Fig. 3 SEM investigation- material defect of the interface

Fig. 4 Absence of marginal adaptation
4 Discussions and Conclusion
Defects were identified to all investigated sample. Different chemical composition and particles size contributed at the appearance of these defects. Contraction of composite resin during light-curing may influence the quality marginal adaptation. Identified micro-defects may lead to failure of the reparation, marginal infiltration, coloration and fracture of the composite resin.

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References: