Introduction

The introduction of digital technology using the computer aided design and manufacturing; the (CAD/CAM) systems, which provide high quality restorations, have dramatically upgraded dental work. This advancement alternated the impression and casting procedure steps to provide faster and easier indirect restorations, without requiring temporization and dental lab work.

There are several types of CAD/CAM ceramic blocks that are newly introduced in the market everyday. What makes them different is the material chemical structure and so their indications.

New materials named resin ceramic hybrid material have been launched for CAD/CAM technique. This material combines the advantages of ceramics such as durability and color stability, with the ones of composite resin such as flexural properties and low abrasiveness. Example of this type of material, the GC CERASMART blocks. It is mainly a high-density composite resin material containing 71% filler particles by weight.

Another new material was recently introduced in the market; the VITA Suprinity. It is a zirconia reinforced lithium silicate ceramic. This newly developed generation of glass-ceramic materials combines the positive material characteristics of zirconia (ZrO_2) and glass-ceramic.

Although all ceramic restorations have exceptional esthetic properties, they have a major flaw; their brittleness. Which is the result of the low tensile stress and fracture toughness of the material. This major drawback in ceramics makes it more susceptible to fracture and chipping.

Usually the fracture of ceramic restorations takes place after cementation because of the masticatory forces especially in case of para-functional habits, change in temperature, saliva and pH changes. In case of any fracture or chipping in the restoration, it is hard to remove the defected restoration without trauma to the sound tooth structure because of the use of adhesive cementation. Plus the procedure is time consuming and has a major cost.

As a result of the difficulty to remove a cemented restoration without damaging the remaining sound tooth structure, intra oral repair with a composite resin material is considered quick and simple with minimal expenses.

Yet, for the repair to resist functional loads, the bond between the fractured restoration and the repair material must be strong and durable. In order to achieve the maximum bond strength between the composite resin and the surface of the fractured ceramic; special surface treatments are applied according to the type of ceramic used in the fabrication of the defected restoration.

Review of Literature

Over the last few years, digital computer technology has been rapidly developing in dentistry. This technology is improving the way the dental practice interacts with patients, keeping their records and financial information, and even the way patients receive treatment.(1)

Electronic and digital technology in addition to advanced manufacturing has been applied in different dental fields and gaining popularity in prosthodontics, orthodontics, oral implantology and oral and maxillofacial Surgery.(2)

Nowadays CAD/CAM systems may be categorized as either chair-side or laboratory systems.(3) The application of (CAD/CAM) technology in clinical practice reduces treatment time and cost, plus it improves the results of the restorations in terms of appearance, accuracy and suitability.(4)

Also CAD/CAM has been very useful in permitting the fabrication of customized, patient-specific restorations and prosthetics without having to use traditional analog dental laboratory methods.(5)

In other words, this chair-side system allows the clinicians in private practice to independently design and also machine dental ceramic restorations in matter of hours, offering final restorations in single visit.(3) Moreover, through CAD/CAM system, we could produce a fixed restoration with the appropriate occlusal contacts, which eliminates the intra-oral adjustment step.(6)

Ceramics

Nowadays, all-ceramic restorations are mostly used in an attempt to avoid the esthetic limitations of metal ceramic restorations. All-ceramic restorations may be fabricated using a variety of all-ceramic materials and fabrication techniques.(7)

Like it was mentioned previously CAD/CAM technology has been introduced as an alternative to traditional manufacturing processes which have led to advances in dental ceramic materials and adhesive technology.(7)

The CAD/CAM block materials for fixed restorations have convenient mechanical and physical properties in comparison to laboratory-processed composites, in addition to the remarkable reduction in voids, flaws, and cracks, fewer discolorations, and higher abrasion resistance.(8)

Different materials have been used with CAD/CAM machining and commercially provided to operators, such as: yttria stabilized zirconia (e.g., IPS e.max ZirCAD) feldspathic porcelain(e.g., VITABLOCS Mark II), glass-ceramic (e.g., IPS e.max CAD), and resin composites (e.g.,Paradigm MZ100).(8)

Recently, a new CAD/CAM hybrid ceramic material for indirect restorations has been developed. This material is based on a polymer-infiltrated-ceramic network material (PICN).

The hybrid ceramic consists of a dominant ceramic network (86 wt%) which is reinforced by acrylate polymer network (14 wt%) with both networks fully penetrating one another. It was manufactured by introducing a lower elastic modulus polymeric second phase into ceramic networks. Therefore, the hybrid ceramic combines the positive characteristics of ceramics and composites.(9)

Such as VITA Enamic, Lava Ultimate and GC CERASMART blocks are recent CAD/CAM materials that provide superior esthetic appearance. These materials join the advantageous properties of ceramics, like durability and color stability, with those of composite resins, such as improved flexural properties and low abrasiveness.(10)

Ceramic materials are widely used in dentistry because of their biocompatibility, chemical inertness, good compressive strength & abrasion resistance, low plaque accumulation, superior esthetics, and color stability. However, their low tensile and flexural strength make the material brittle and sensitive to flaws and defects.(11)

Glass-ceramics, also termed silica-based ceramics, are a group of materials that have been widely used for all-ceramic restorations since the 1970s. These can be further classified as feldspathic, leucite-reinforced, fluormica glass or lithium disilicate ceramic.(12)

The use of glass-ceramics in the posterior region is restricted to single-tooth restorations (inlays, onlays and crowns), because of the high forces exerted in this part of the mouth.(13) Microstructure of glass-ceramics, such as crystal size and crystal volume fraction, played a vital role in the mechanical properties, wear behaviors and wear resistance.(13)

In order to extend the indication range of glass-ceramics beyond that of the anterior teeth, a glass-ceramic had to be developed that showed significantly higher strength and fracture toughness compared with the leucite type glass-ceramics. This material demonstrates a significantly higher crystal content (up to 70 vol %) compared with that of leucite glass-ceramics. Due to the high crystal content and the high degree of interlocking crystals, this glass-ceramic exhibits a strength of 350 MPa and a fracture toughness of 2.5 MPa $m^{1/2}$. This material (IPS e.max® Press) is suitable for fabricating crowns and frameworks for three-unit bridges.(13) A machinable version of the lithium disilicate-reinforced ceramic blocks with low-translucency color was then introduced.(14)

Lithium disilicate glass-ceramics (e.max) are notable for excellent transparency and personalized colors, thus have become an indispensable part of dental aesthetics. Different from other dental ceramic materials, lithium disilicate glass-ceramics contain an interlocking microstructure of a glass matrix and a crystalline phase, which results in the effective strengthening and esthetic performance.(15)

Lithium disilicate glass-ceramic is recommended for fabrication of highly esthetic restorations in both anterior and posterior regions in the oral cavity.(11)

Tsitrou et al. in 2007 (16) conducted a study to investigate any possible correlation between the brittleness index of machinable dental materials and the chipping factor of the final restorations. The results of this study showed that the chipping factor varies according to the material used. It was found that the composite material (ParadigmMZ100) had the lowest chipping factor while the lithium disilicate glass-ceramic (IPS e.max) had the highest chipping factor. The feldspathic (VITA MKII) and leucite reinforced glass-ceramic (ProCAD) showed similar chipping factors. A material with greater level of chipping during milling is likely to have a reduced quality of marginal fit because of greater damage to the margins. This might be the case for the IPS e.max ceramic whose physical properties are improved by subsequent firing.

Vita Suprinity

Due to the chipping occurring in the e.max, when milled in very thin sections, VITA Suprinity was presented. VITA Zahnfabrik introduced VITA SUPRINITY PC in the market since May 2016, a generation of glass-ceramic material products. With the aid of an innovative manufacturing process, glass-ceramic is enriched with zirconia (approx. 10 % by weight). The result is a zirconia reinforced lithium silicate ceramic (ZLS).(17)

This glass-ceramic features a special fine-grained and homogeneous structure, which guarantees excellent material quality and consistent high load capacity, as well as long- term reliability. Moreover, the material also offers outstanding processing characteristics such as easy milling and polishing. (18)

VITA SUPRINITY PC provides excellent esthetic properties and offers a wide range of indications that includes anterior and posterior crowns, supra structures on implants, veneers, inlays and onlays.(18)

According to the manufacturers, these materials offer mechanical properties ranging from 370 to 420 MPa. Therefore, they are comparable with the clinically well-proven lithium disilicate glass-ceramics.[19]

The improved strength and reliability are reached by the addition of 8–10wt% of zirconium oxide. After crystallization, the presence of zirconia causes a homogeneous texture to form with a mean grit size of approximately 0.5 to 0.7 μm. The formed crystals are 4 to 8 times smaller than lithium disilicate crystallites.

Thus, Zirconia reinforced Lithium Silicate ceramics consist of a dual microstructure:

(i) Very fine lithium metasilicate and lithium disilicate crystals (average size: 0.5–0.7 μm); this is the main difference from Lithium disilicate ceramics, which only contain lithium disilicate crystals.

(ii) Glassy matrix containing zirconium oxide in solution.[19]

This dual microstructure is achieved in a two-step process.

The material is delivered in a pre-crystallized stage, containing only lithium metasilicate crystals. In its pre-crystallized phase, the material is easy to machine. After the water-cooled milling process and the finishing of the restoration, the final dual lithium silicate microstructure is reached during firing process at 840ºC for 8 minutes.[20]

El-Saka and El-Naghy in 2016,[17] conducted a study to assess the mechanical properties of recently introduced zirconia reinforced lithium silicate glass-ceramic. They used two types of CAD/CAM glass-ceramics

(VITA Suprinity (VS); zirconia reinforced lithium silicate and IPS e.max CAD (IC); lithium disilicate). Fracture toughness, flexural strength, elastic modulus, hardness, brittleness index, and microstructures were evaluated. Data were analyzed using independent *t* tests. Weibull analysis of flexural strength data was also performed. The VS glass-ceramic revealed a lower probability of failure and a higher strength than IC glass-ceramic according to Weibull analysis. The significance of this study showed that the VS zirconia reinforced lithium silicate glass-ceramic revealed higher mechanical properties compared with IC lithium disilicate glass-ceramic.

Rinke et al. in 2015(19) described in their case report the fabrication of monolithic all-ceramic restorations using zirconia-reinforced lithium silicate ceramics. They concluded that the newly introduced ceramic materials offer a unique combination of fracture strength (>420MPa), excellent optical properties, and optimum polishing characteristics, thus making them an interesting material option for monolithic restorations in the digital workflow.

CERASMART

CERASMART (GC) is a high-density composite resin material containing 71% filler particles by weight.(10)

Awada et al. in 2015(21) compared mechanical properties (flexural strength, flexural modulus, modulus of resilience) and the margin edge quality of recently introduced polymer-based CAD/CAM materials (Lava Ultimate, Vita Enamic and CERASMART) with some of their commercially available composite resin (Paradigm MZ100 Block) and ceramic(IPS Empress CAD, Vitablocs Mark II) counterparts. They concluded that the mean flexural strength of CERASMART and Lava ultimate was significantly higher than that of the other ceramic and polymer-based CAD/CAM restorative materials tested (Enamic, Vitablocs Mark II, Paradigm MZ100, and IPS impress II).

The mean flexural modulus of CERASMART and Lava Ultimate was significantly lower than that of the other ceramic and polymer-based CAD/CAM restorative materials tested in this study. The mean modulus of resilience of CERASMART and Lava Ultimate was significantly higher than that of the other ceramic and polymer-based CAD/CAM restorative materials tested in this study. The polymer-based materials tested in this study seem to exhibit smoother milled margins compared with the ceramic materials tested.(21)

Lawson et al. in 2016(22) measured the mechanical properties of several CAD/CAM materials, including lithium disilicate (e.max CAD), lithium silicate/zirconia (Celtra Duo), 3 resin composites (CERASMART, Lava Ultimate, Paradigm MZ100), and a polymer infiltrated ceramic (VITA Enamic). Results showed that the “hybrid” materials had a lower flexural strength than the glass-ceramics. The resin composites had a lower elastic modulus and hardness than the infiltrated ceramic, which in turn had a lower elastic modulus and hardness than the glass-ceramics. The resin composites and infiltrated ceramic experienced less wear than natural enamel whereas the glass-ceramics experienced more wear than enamel. The resin composites caused less opposing enamel wear than the infiltrated ceramic and the glass-ceramics.

Stawarczyk et al. in 2016 [23] conducted a study to determine the mechanical and optical properties of CAD/CAM composites (Lava Ultimate, CERASMART, Shofu Block and two exp. CAD/CAM composites), a hybrid material (VITA Enamic), a leucite (IPS Empress CAD) and a lithium disilicate glass-ceramic (IPS e.max CAD). They concluded that CAD/CAM composites showed higher flexural strengths than leucite ceramic and the hybrid material VITA Enamic, but lower ones than lithium disilicate ceramic. The highest Weibull modulus was observed for the hybrid material VITA Enamic, followed by the CAD/CAM composites and the lowest one for lithium disilicate ceramic. Only one CAD/CAM composite (exp. CAD/CAD composite2) showed comparable wear properties with the tested glass- ceramics and the hybrid material remaining CAD/CAM composites presented higher material loss than glass-ceramics. The hybrid material and the glass-ceramics showed higher human tooth antagonist wear than CAD/CAM composites. Specimens stored in red wine, followed by curry and cress showed higher discoloration rate than specimens stored in distilled water. Glass-ceramics showed lower discoloration rate than CAD/CAM composites.

Repair Material (Ormocer)

According to ***Kalra et al. in 2012*** *[24]* the traditional composites have many limitations and concerns; as a result in an attempt to overcome these disadvantages a new packable restorative material was introduced called Ormocer.

Ormocer stands for organically modified ceramic technology, this material contain inorganic-organic co-polymers in addition to the inorganic silanated filler particles.[25]

It is considered a type of direct bonded composites resin, it was introduced in the market to increase wear resistance, decrease the polymerization shrinkage and enhance the biocompatibility of resin-based material.[26]

El-Askary et al. in 2016 *[27]* evaluated the micro-shear repair bond strength of a new Ormocer restorative material as a function of repair time and repair protocol. Ormocer disks were prepared and divided into 14 groups: 1st according to Bonding protocol (NoConditioning, Admira Bond, Futurabond M+, Silane/Admirabond, Silane/Futurabond M+, Ceramic repair system, Silane/Cimarabond) and 2nd according to repair procedure time (immediate versus delayed). They concluded that the use of self-etching adhesive resin or ceramic repair kit could be advised for immediate repair of the new Ormocer material. For delayed repair, except for Admirabond, any bonding protocol employed in this study could be used, provided that adhesive failure types were more predominant and no cohesive failures were observed after any of the repair protocol.

Kalra et al. in 2012 [(24)] compared the marginal sealing ability of an Ormocer-based material (Admira) and a hybrid composite (Spectrum TPH) using an Ormocer based bonding agent (Admirabond) and a conventional fifth generation bonding agent (Prime and Bond NT). They found that Admira used with Admira Bond exhibited lesser microleakage than Spectrum TPH used with Prime and Bond NT, the difference being statistically insignificant.

Cunha et al.in 2003 [(25)] compared the surface roughness of two Ormocer-based resin composites (Admira and Definite) and two composites based on conventional monomer systems (Bis-GMA, Bis-EMA, UEDMA TEGDMA) (Z250 ad A110), before and after mechanical tooth brushing. They concluded that all composites showed a statistically significant increase in the surface roughness after tooth brushing.

Fracture and repair:

Although the ceramic restorations that are produced by machining ceramic blocks may optimize and improve the structural reliability, but the effect of the machining process on the long-term stability of the restorations must be taken under consideration. According to the grinding mechanism of ceramic materials, analysis of the chipped fragments and cutting forces showed that ceramic material removal is dominantly a brittle fracture mechanism.[(28)]

However, all-ceramic restorations may still fail as a consequence of fractures, cracks, or chipping due to their brittle nature and structural flaws. The removal of fractured ceramic restorations may sacrifice the remaining sound tooth tissue and weaken the tooth.(7)

So repairing such restorations by bonding composites directly to the exposed ceramic is cost effective, easy to perform, and offers good esthetics. Therefore, while improvements to ceramics continue, it would be beneficial to already have a predictable means of repairing fractured ceramic restorations as minimally invasively as possible.(7)

In a recent survey conducted by ***Staxrud et al. in 2016*** (29), it was found that almost eight out of nine dentists preferred repair of failed restorations when damage was small.

Adhesive dentistry brought into perspective the possibility of the repair of pre-existing restorations rather than their complete replacement.(30)

A lot of factors influence the bond strength between materials in case of performing a repair procedure. Among these factors, material compositions, surface conditioning methods in the form of either chemical, mechanical, or combination of both, the use of silane coupling agents and repair time; either immediate or delayed. Could all affect the adhesion in repair attempts.(27)

Pacifica et al. in 2013 ***(31)*** explained that the repair of ceramic restorations is done by certain materials such as resin based luting cements, composite resins and ceramic materials; they are selected because of their mechanical physical and esthetic properties.

Manhart and Frasheri in 2016 [32] presented a case report where an intra-oral repair of a glass-ceramic inlay in a maxillary first bicuspid using a flowable nanohybrid Ormocer and a regular viscosity nanohybrid Ormocer after surface treating the fracture site with roughening and tribochemically silica coating (CoJet) using an intra-oral air-abrasion device.

Surface Treatments:

To date, there appears to be no consensus for the most appropriate way to prepare the substrate to be repaired. So in addition to roughening with diamond burs, sandblasting, etching with hydrofluoric acid, lasers and silane application have been suggested.[29]

Before cementation of ceramic restorations, different surface treatments methods such as airborne particle abrasion (sandblasting) with aluminum oxide, hydrofluoric (HF) acid etching, or laser irradiation are employed to improve the resin-ceramic bond strength.[28]

It has been shown that these surface treatments which increase the irregularities on the ceramic surface might be the source of future failure and adversely affect the fracture resistance of the ceramic restorations.[28]

Surface treatments are shown to improve the bond strength of resin composite to CAD/CAM resin-ceramic hybrid materials for repair.[33]

The intra-oral surface treatment of defective glass-ceramic restorations prior to the application of the repairing composite can be done using hydrofluoric acid etching or tribochemical silica coating (CoJet). Etching with hydrofluoric-acid gel followed by silanization is a well-