The Effect Of Surface Treatments and pH media On Micro-Shear Bond Strength Of Lava Ultimate Using Two Resin Cements

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Dedication to

My dear mother

This is all for you, Mom. You gave me life, fought for me and most importantly your unconditional love.

Mom, I do love you

My dear father

Thank you, for keeping my chin up, for making me proud of you, for your care and support.

May his soul rest in peace

The constant seek for finding the ultimate esthetic restorative material has led to many alternatives. Due to their high esthetic appearance and metal-free structure, tooth colored, all-ceramic restorations have become the main concern in prosthetic dentistry. Using the newly introduced non-metallic restorations, in addition to having optical properties simulating that of natural teeth, it should also have acceptable physical properties that can withstand the oral environment.

The need for non-metallic restoration with high optical properties and characteristics such as; biocompatibility, color stability and high wear resistance is often stated as a reason for the use of ceramics in dentistry. Continued development in ceramic materials leaded to extend the indication of using the all-ceramic materials. This has led to greater use of adhesive resin cements to provide strength of all-ceramic restorations and to ensure secure bonding interfaces.

Cement selection and surface treatment are crucial for strong and long term bond between ceramics and the cement. The success and survival of ceramic restorations depends to a great extent on the ceramic-cement interface bond. So, using a modern adhesive systems and proper selection of surface treatment considered to be a corner stone that allowing a long-term bond, better adhesion and durability of the restoration.

A newly introduced material (Resin Nano-Ceramic) Lava-Ultimate CAD/CAM restorative material is the direct result of using true

nanotechnology on the dental field. Lava-Ultimate is a promising new material that can be classified as Nano-ceramic restorations. It distinguish itself by precise manipulation of the ceramic architecture at the Nano-scale (1-100nm), yielding unique and controllable properties. The nanotechnology on Lava-Ultimate restoration is coupled with resin technology to achieve a combination of strength and esthetic beyond what current ceramics offer.

The newly introduced material Lava-Ultimate not only provides an excellent esthetic, but also its mechanical properties allow this milling blocks to introduce it-self as a strong competitor in metal-free structures. Lava-Ultimate has a slightly different cementation protocol, so a proper selection of adhesive system and the suitable surface treatment is the point of interest.

The effect of PH media and surface treatment on the bond strength between Lava- Ultimate and two types of resin cements is the aim of this study.

The quest for achieving the ultimate esthetic requires the array of different factors; proper case selection, clinical experiences and selecting the appropriate material considered to be the corner stone.

Improved esthetics, biocompatibility and color stability are the driving reasons for the wide use of all-ceramic restorative materials. With the increase in demand and interest in using ceramic materials, a strong and durable bond between ceramics and resin cements is the key for success and long term clinical survival of the restorations. [(1)]

By classifying ceramics into silica-based and non-silica based ceramics, HF-acid etching or sandblasting and grinding can be used respectively providing a mechanical bond through infiltration of adhesives into the micro-retentive ceramic surface. Further chemical bonding can be obtained by using a silane coupling agent with silica based ceramics. [(1, 2)]

Unfortunately, non-silica based zirconia ceramics has a silica free surfaces; therefore using HF-acid etching will not be effective. Furthermore, grinding or sandblasting may promote zirconium degradation. Subsequently silica coating techniques can be used to convert the non-polar silica free surface zirconium surface into silica rich surface to utilize the chemical bond provided by silanation which significantly enhance bond strength and durability. [(3, 4, 5)]

All- ceramic restorations

Revolution in dental ceramics in respect to optical properties, composition and indications concluded that all-ceramic materials are used widely.[6]Dental ceramics can be classified according to their microstructure, which aids in understanding both the chemical nature and the structure of the ceramics.[7]

Both composition and processing techniques influence ceramic's clinical behavior; therefore, classifying ceramics according to their composition and processing manner aids in selecting the appropriate material for each clinical situation. Thus, dental ceramics can be classified into three major categories: porcelain, which contains mostly a glass phase, glass which has a high concentration of reinforced crystals and a polycrystalline which are composed of mostly crystals.

Resin ceramics recently represented a new category of dental ceramics, providing a high esthetic properties, high polishability and shorter milling time. Additionally, resin ceramics provide a significant improvement in mechanical properties. [8]Resin ceramics can be subdivided into three divisions: resin-Nano ceramics, glass-ceramics in a resin interpenetrating matrix and zirconia-silica ceramic in resin interpenetrating matrix. [9]

CAD/CAM

(Computer Aided Design/Computer Aided Manufacturing)

Considering all-ceramic restorations, the most esthetically pleasing restorative material requires continuous modification in their microstructure, composition and processing in order to achieve a satisfactory level in their clinical behavior. By introducing the CAD/CAM technology a new era has started in processing techniques of all ceramic materials.

CAD/CAM technology was initially developed in an attempt to surpass already existing techniques and to provide processes for producing ceramics with natural looking material, making tooth restoration more efficient, and achieving more accurate restoration. The new techniques can be applied to different indirect esthetic restorations such as veneers, crowns, fixed partial dentures, on-lays and in-lays, in addition to full-mouth reconstruction. [10]

CEREC (computer assisted ceramic reconstruction) is a combination of using optics to scan the prepared teeth and a milling device to fabricate the desired restoration was introduced by **Mormann in 1985.** It was considered to be the first commercial CAD/CAM system. [11, 12] The earliest model of CEREC was capable of constructing onlays and inlays only. Later, the CEREC AC in 2009 was introduced with the ability to create different indirect designs such as bridges, veneers and crowns. [13]

CAD/CAM systems are very promising revolutions in dental ceramic fabrication and processing. As prices come down and dentists become more familiar and comfortable with the new technology it is expected to be widely applied.

LAVA ULTIMATE

Science is presently undergoing a massive and great evolution taking humanity to a new era, Era of the nanotechnology. Nanotechnology is based on revealing the unique properties of structures by working on a nanometer scale. (14) Nanotechnology is anticipated to provide great advances in the dental field. (15)

3m ESPE is utilizing the nanotechnology to create the resin nano-ceramics. Lava-Ultimate is the newly introduced unique CAD/CAM block which is considered to be the direct result of applying the nanotechnology in the dental field.

Lava-Ultimate contains two types of monodisperse and nonagglomerated nanomer particles: silica nanomer of 20nm diameter and zirconia nanomer of 4-11nm diameter. Additionally, zirconia-silica nanocluster particles average 0.6 to 10 micrometer in size. A silane coupling agent is used to treat the engineered particles to chemically bond the resin ceramic surface and the resin matrix during block fabrication. The reinforced resin matrix has a unique composition that provides significantly improved mechanical properties. The CAD/CAM resin nano-ceramic is fabricated with about 80% by weight nano-ceramic filler loading. (16)

Applying the nanotechnology and resin technology in producing resin nano-ceramics resulted in a masterpiece material. It combined high strength, wear resistance, polish retention and excellent optical properties. The new mill block considered to be a revolution in indirect esthetic restorations that transgress the limits of what current ceramic materials provide.

Wiedig et al in 2012[17] used different adhesive resin cements with their acclaimed pre-treatment protocols to compare their shear bond strength with resin Nano ceramics (lava ultimate), titanium and Ni-Cr-alloy. The resin cements tested were Multilink Automix, Variolink II, Panavia F2.0, Clearfil Esthetic Cement ,NX3 ,RelyX Ultimate (3MESPE).Stainless steel rods having a diameter 4mm cemented with a standard pressure (20 g/mm2) onto the restoration material specimens and cured. All the Specimens stored for one day at 36 c and 100% humidity, where half of the specimens artificially aged (5.000 thermal cycles). Shear bond test was run using a universal testing machine with a crosshead speed 0.75 mm/min). Their results concluded that the highest adhesion values recorded where using Relyx ultimate and its recommended pre-treatment by scotchbond universal adhesive.

Varpavaara et al in 2012[18] assessed the influence of surface treatments of Lava- Ultimate (resin nano-ceramics) and two primers on the shear bond strength to resin cement. The specimens were divided into groups regarding to the surface treatment and primer used. Relyx Ultimate resin cement was used with its primer or another silane ceramic primer (3M ESPE). The study concluded that lava primer showed higher

bond strength results than the other silane ceramic primer. Rocatec followed by sandblasting using 30 µm aluminum oxide revealed higher results, while hydrofluoric acid etching had the weakest bond strength tested. Moreover they concluded that grinding by 500 grit SiC paper showed a significant difference in bond strength between lava primer and ceramic primer, where lava primer had better results. Additionally they clinched that conventional surface treatments enquire the most reliable bond strength.

Truco et al in 2012[19] assessed the effect of chewing fatigue on the micro-tensile bond strength of Vita (MarkII) and Lava- Ultimate bonded to dentine structure with Relyx Ultimate Resin Cement (used with Scotchbond Universal Adhesive) or Variolink (II) cement. With both Lava- Ultimate and Vita Mark II the bond strength of Relyx Ultimate was not significantly affected after and before chewing simulation, while Variolink II showed a significant low bond after chewing simulation.

Vidotti et al in 2012[20] assessed the micro-tensile bond strength of direct and indirect resin composites to Lava Ultimate Restorative. Ten Lava Ultimate blocks polished with 600 grit silicon carbide papers or sandblasted with 50µm aluminum oxide particles then cleaned in an ultrasonic bath. After application of one-step-total etch adhesive an indirect or direct composite applied to the Lava Ultimate blocks. The results showed that micro-tensile bond strength was not significantly different with both direct and indirect composite and it may suitable for intra-oral service.

Rusin et al in 2013[21] appraised the shear bond strength of a Nano-composite to Lava Ultimate before and after conditioning in artificial saliva to stimulate oral conditions. Results showed that the shear bond strength was not significantly different after artificial saliva conditioning and before and after thermo cycling.

Shinohara et al in 2013[22] assessed the influence of surface treatments on the micro-tensile bond strength of Lava-Ultimate to direct composites. Lava ultimate blocks subjected to three different surface treatments; control (no treatment), grinding with fine diamond bur and sandblasting with 50μm aluminum oxide particles for 10 seconds. After 24 hours storage the blocks was tested. The SEM analysis revealed predominance cohesive fractures in direct composite. The surface morphology of the sandblasted and grinded specimens showed more irregularities than the control, while using them as a surface treatment for repair using direct composite did not affect the bond strength.

Arpa et al in 2014[23] assessed the effect of different surface treatments on repair micro-tensile bond strength of artificially aged Lava Ultimate. Twenty one lava ultimate blocks (6.0x6.0x5.5) were prepared, thermocycled (10,000 cycles, 5-55°C) and then haphazardly allocated to one of seven surface treatments protocols:(1) Silica coating and Scotchbond Universal Adhesive; (2) Silica coating, silane and Adper Scotchbond (3) Sandblasting with alumina particles, phosphoric acid with SBU; (4) sandblasting by Alumina, PA, SI and XT; (5) Abrasion using (280) grit silicon carbide paper, PA and SBU; (6) 4.9 % HF- etching for 20s and silane application; (7) PA and XT. Filtek Supreme XTE (3M

ESPE) resin composite were used to repair the treated blocks of lava ultimate .results showed that Surface treatment using HF acid etching and application of silane reported a 100% pre-test failures and for the groups repaired with PA application followed by XT Adhesive presented statistically lower results than the others groups that having a Comparable mean results. Results indicated that using hydrofluoric acid as a surface treatment to repair lava ultimate is not acclaimed.

Stawarezyk et al in 2014 [24] appraised the outcome of pretreatment method (air abrasion and Al2O3 grinder), the conditioning method (different adhesive systems), the repair composite, the water contamination of (CoJet air-abraded surfaces), and the effect phosphoric acid on the macro-tensile bond strength to aged lava ultimate. Lava ultimate discs were aged for (10,000) thermal-cycles and then the specimens arbitrarily divided into 3 pretreatment protocols (CoJet) dry air and wet abrading and cimara grinding. Then half of the tested groups cleaned using phosphoric acid and the other half rinsed by water. The treated surfaces conditioned using different adhesive systems (Futurabond U, One Coat Bond, Scotchbond Universal and VisioLink, while no conditioning serving as the control group. After that specimens repaired using two direct composite (Grandio S and Arabesk top). Results revealed that air abrasion produced higher tensile bond strength than grinding; also water or phosphoric acid contamination did not have a significant effect on repair bond strength. Additionally, the conditioning method showed a significant effect on bond strength.

Spitngal et in 2014 [25] appraised the scientific evidence on the resin bond to indirect composite and new ceramic/polymer materials.in this review they focused the different pretreatments steps and adhesive systems. They concluded that AL2O3 abrasion, silane , and HF-etching are the most frequently used surface treatments applied to indirect composite restoration and Air-particle abrasion followed by silane application boosted the bond between resin and laboratory-processed composites. Yet, further studies are needed to value the bond strength to new ceramic/polymer materials. Additionally they revealed that Self-adhesive resin cements accomplish lower bond strengths in comparison with adhesive resin cements.

Mesmar et al in 2015[26] assessed the effect of different protocols of surface treatments on bonding between adhesive resin cement (RelyX Ultimate) and new CAD/CAM materials; Lava-Ultimate, Enamic (Vita-Zahnfabrik) and a ceramic (IPS e.max - Ivoclar). Lava treated by both Rocatec soft and sand-blast, while Enamic and e.max were treated with HF-etcing. After Bond strength test was performed the bonded surface of the specimens scanned by SEM. The results for Lava Ultimate revealed that, surface silicatisation appears to be a more effective than sandblasting. Therefore, surface treatment of Lava-Ultimate using Rocatec soft (30 μm silica-modified AL2O3) is indorsed. Moreover for Enamic and IPS e.max, silane application followed by application of adhesive is widely recommended than combing silane and adhesive in one solution. Additionally the results concluded that For Lava Ultimate, crack propagation occurred mainly cohesively via the adhesive resin