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Effect of different types of resin cements on micro tensile bond strength of CAD/CAM ceramic after immediate dentin sealing.

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ABSTRACT
The aim of this in-Vitro study was to evaluate microtensile bond strength of immediate dentin seal under different resin cements (total etch /self-etch/self-adhesive).Sound natural molar teeth extracted due to periodontal causes were collected, disinfected, cleaned, and flattened occlusally to expose superficial dentin surface using microsaw (Isomet),then immediate dentin seal will be applied on all teeh surfaces. Tooth specimens was temporary sealed then was stored in distilled water for 1 week, then groups will divided according to the type of permanent resin cement into three subgroup(total etch/self-etch and self-adhesive).lithuim disilicate were cut by micrsaw into rectangles and crystallization. After cementation of rectangles with teeth specimen, each specimen was cut into microbars ($1mm^2$) using isomet. Evaluation of microbars using stereomicroscope was done to select intact microbars (20 microbars for each group). Failure mode detection was detected with stereomicroscope (50 X) and scanning electron microscope (75 X, 1000 X, and 2000 X). Then, failure mode underwent statistical analysis. Then, microtensile bond strength test was performed. Microtensile bond strength values for groups were collected, tabulated and statistically analysed using two way ANOVA test.
There is no significance difference using different type of resin cement..

Key Words: Lithium disilicate, immediate dentin seal, Resin coating technique, Microtensile bond strength, Resin cement, cleaning technique, Temporary cement.

I. INTRODUCTION

The clinical success of an indirect restorative procedure is influenced by the cementation technique that used to create a link between the restoration and the tooth. With the advancement of adhesive materials and their greater reliability that can increase the life span of indirect restorations and decrease dentin sensitivity after preparation, adhesive materials and technology are revolutionized as clinical procedures in dentistry. (1)

In most of cases, significant amounts of exposed dentin are usually unavoidable during teeth preparation, management of dental tissue between preparation and cementation plays a vital role in prevention of post-operative sensitivity and microleakage.(2) Therefore, several methods are used as Immediate Dentin Sealing (IDS). IDS is the application of dentin bonding agent to freshly cut dentin when it is exposed during tooth preparation for indirect restorations.

IDS is a progressive protocol designed to address the challenges of preparation, temporization and final cementation of indirect restorative procedures. It is performed after tooth preparation prior to impression and offers several distinct advantages which prevents bacterial invasion, dentin sensitivity, protects the dentin and pulp through the formation of a hybrid layer(3,4),improves the resin cement-dentin bonding of indirect restoration (5,6) and reduces pain caused by external physical stimuli as it seals the dentinal tubules. (7,8)

IDS is an optimized dentin bonding mode that was used since the mid1990s and are recommended as bonding strategy when using indirect or semi-indirect bonded restorations. Magne(9) recommended the application of dentin adhesive to freshly cut dentin when a significant area of dentin is exposed during tooth preparation for indirect restoration. The technique can be applied not only to vital teeth but also to non-vital teeth after endodontic treatment. (1)
The prepared tooth surface should be covered temporally to provide positional stability, adequate occlusion and facilitate proper oral hygiene measures..

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II. MATERIALS AND METHODS

Materials used in the present study were lithium dislicate (Rosetta®SM), hydrofluoric acid biscoetchant,MonobondN ,TetricN universal bond ,multilink N resin cement ,Multlilink speed resin cement,Variolink DC resin cement ,and non-eugenol temporary cement NTC.

Mandibular molars used in this study were collected from Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University. Teeth were extracted due to periodontal causes from patients with average age 45-60 years, with ethical approval (No. 19030821) from the Research Ethics Committee at the Faculty of Dentistry, Mansoura University, Egypt.

Teeth were disinfected by immersion in 1:10 diluted 5.25% sodium hypochlorite household bleach (Clorox bleach, Clorox co., Cairo, Egypt) for 7 days.

Specifically-designed centralization metal device was used to accurately center the teeth in the acrylic resin blocks[10] . Teeth were flattened to expose the dentin surface for microtensile bond test and cutting was done under water cooling exposing dentin 1mm beneath the dentinoenamel junction by micro saw machine Isomet(Isomet 1000; Buehler, Lake Bluff, IL, USA).Lithium disilicate was cut into rectangular blocks of 8 mm length × 8 mm width × 4mm thickness with the microsaw cutting machine and were subjected to crystallization cycle in special furnace (programat EP3010 furnace, ivoclarvivadent), (Crystallization /firing program as recommended by the manufacturer was done with a starting temperature 400°C , increased at a rate of 60 °C /min ,vacuum was on at 550O C ,the temperature was increased till it reached 840°C and held for 10 mins with vacuum off, the temperature was lowered to 700°C and left to cool down at room temperature. The specimens were grouped randomly according to dentin sealing techniqueinto three main groups according to resin cement technique used : Group T: Total etch resin ,group **S**: Self etch resin cement ,group A: Self Adhesive resin cement .

Tetric N bond universal adhesive was applied over the whole dentinocclusal surface according to the manufacturer's instructions. A single coat of the adhesive was applied and rubbed for 20 sec. , then blown with a gentle air blow for 5 sec. to evaporate the solvent and then light cured for 20 sec using LED curing (BlueLEX LD-106, Monitex, China) at a light intensity of 1200 mw/cm2 and then isolated with petroleum jel (Vaseline, Unilever, London, UK) then polymerized for an additional 10 sec. [11]

All teeth were sealed with non- eugenol temporary cement and stored in distilled water at 37^{O} C for 1 week.

Lithium disilcate rectangles were cleaned ultrasonically and etched with buffered hydrofluoric acid gel(9.5%) for 20 sec, then the surface was rinsed with a copious amount of water and air dry, so the etched surface appeared dull and frosty. A thin coat of silane coupling agent was applied with a microbrush to the etched surfaces of ceramics and allowed to dry for 60 sec .
Surface treatment of tooth structure according to resin cement used:

Group T: Total etch resin cement group.

Each tooth surface in this subdivision was etched using 35% phosphoric acid for 15 sec, then rinsed for 20 sec and gentle air-dried for 3 sec (without desiccation). A coat of Tetric® N-Bond Universal was applied using a microbrush and agitated for 20 sec, then gently blown with compressed air till the surface became glossy later ,the adhesive was light cured for 15 sec. Cementation were made directly after surface treatments ,the Variolink DC cement syringe was pressed and dispensed on the bonding surface of lithium disilicate specimens, the teeth specimen were bonded to lithuim surface using a specially-designed cementation device with static loading of 1 kg for 5 min.[12] The cement was initially light-cured from all surfaces for 3 sec at right angle using the LED light curing unit. The excess was gently removed by disposable microbrush[13], the bonded specimens were further light-cured for 10 sec for each side according to the manufacturer's instruction. Group S: Self-etch resin cement group

The Multilink N Primer A and B were mixed in 1:1 ratio, were applied and scrubbed on the prepared tooth surface for 30 sec. Excess was air blown until the mobile liquid film was no longer visible then the primer was left to self-cure. The Multilink N cement syringe was pressed and dispensed on the bonding surface of lithium disilicate specimens, the cementation load and steps were done as mentioned before with the total etch group .

Group A: Self-Adhesive resin cement.

No further surface treatment of dentin surface had been done.

The Multilink speed cement syringe was pressed and dispensed on the bonding surface of lithium disilicate specimens, the cementation load and steps were done as mentioned before with the total etch group.

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All cemented teeth specimens were stored in distilled water for 24 hours before preparation for microtensile test.

Specimen cutting:

Each cemented tooth specimen was attached from its acrylic resin block to the metallic part of the microsaw cutting machine. The cutting disc was aligned to be perpendicular to the surface of ceramic, first cut was done with constant water-cooling perpendicular to the bonded area starting from lithium disilicate outer side to the resin cement area then dentin until the level of the cementoenamel junction. Several cuts were repeated with the tooth fixed in its position, After that, the cemented tooth ceramic block was turned 90 degrees and connected to the metallic base once more,and the same cutting procedure was carried out to create microbars with dimension of 1 mm^2. The microbars were examined with stereomicroscope (MA 100 Nikon stereomicroscope Japan) at 50 x magnification to select intact microbars without any microcracks and 20 intact microbars were selected for each subgroup.

Microtensile bond strength test:

A specially designed stainless steel attachment consisted of two parts, with a central socket was fixed into the Universal Testing machine (3345, Intrson, 2519-104, 3345, Canton, MA, USA). The applied tensile force was set at a crosshead speed of 0.5 mm/min till faliure occurred. The machine computer software (BlueshillLite software, Intrson, MA, USA) was used to measure the values in Mega Pascal (MPa) by equation that the failure load (N) is divided to the adhesive area (mm^2). Stereomicroscope examination :

The stereomicroscope was used to observe specimens after microtensile test to record the mode of failure which could be :

Adhesive failure between resin and dentin or resin and lithium disilicate

Cohesive failure within dentin, lithium disilicate, resin cement .Mixed adhesive and cohesive failures.

Scanning Electron Microscope (Jeol, JSM-6510LV, Japan) was used to evaluate modes of failure after microtensile test at 75 X, 1000X, and 2000 X magnifications providing better confirmation of the analysis of the failure mode.

All the data were collected tabulated and then statistically analysed using SPSS software, version 25 (SPSS Inc., PASW statistics for windows version 25. Chicago: SPSS Inc.). Qualitative data were described using number and percent. Quantitative data were described using median (minimum and maximum) for non-normally distributed data and after testing normality using Shapiro Wilk test Table Significance of the obtained results was judged at the (≤0.05) level using two way ANOVA test.

III. RESULTS

One Way ANOVA test was used to assess change (Type of resin cement) on microtensile strength (dependent variable) after log transformation and demonstrates that type of resin cement have no significant effect on micro tensile strength.

Sealing technique	**Type of resin cement**			**Test of significance**	**Within group significance**
	Total-etch	Self-etch	Self-adhesive		
	Median (Min-max)	Median (Min-max)	Median (Min-max)		
IDS	8.29 (3.32-16.22)	8.89 (2.56-12.88)	8.92 (4.54-17.91)	Kw=0.529 P=0.768	P1=0.821 P2=0.427 P3=0.650

Figure 1Descriptive statistics of the studied groups

Shows that median micro tensile strength was higher among self adhesive followed by total The stereomicroscope was used to examine the microbars after microtensile bond strength testing fracture to record the mode of failure.

Statistical analysis:

Failure modes between studied groups

etch followed by self-etch and as regard sealing techniques

were statistically analyzed showing thatno statistically significant difference between different types of resin cement technique as regard mode of failure .Within total etch group (p=0.220) Within Self-etch group (p=0.458) and for Within Self-adhesive group (p=0.179)

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IV. DISCUSSION

Clinical practice presents a challenge for dentin bonding, and as CAD/CAM ceramic restorations need a strong and stable adhesion, bonding methods need to be improved for the best possible outcome. Immediate dentin sealing has been developed in order to achieve sufficient bond strength between ceramic and tooth structure with different techniques of resin cement. The choice of the temporary sealing cleaning procedure affected the final bonding of CAD/CAM ceramics.. The current in-Vitro study was done to evaluate the effect of different resin cement technique on micotensile bond strength between dentin and glass ceramics after (IDS). Freshly extracted human molars were used as they have large dimensions resulting in large dentin bonding surface. Natural teeth were used due to their bonding characteristics, modulus of elasticity, and strength and simulating the clinical conditions better than bovine or acrylic teeth [(14)].Immediate dentin seal (IDS) was done on freshly cut caries –free dentin as Magne[(9)] recommended to provide the optimum substrate for bonding..

Active application of universal adhesive in Immediate dentin sealing, in total etch group T using agitation technique accelerated evaporation of solvent and led to better penetration of monomers inside smear layer, so improving bond strength of adhesive to dentin[(15)]

The hypothesisof this study was rejected as there was no signifcanc difference between the three types of resin cement used in increasing bond strength,however group A showed the highest bond strength(8.92 ±3.98 Mpa) this can be attributed to its composition and decreased the ability to etch the tooth surface. Multlink N self etch resin cement used containshydroxyethyl methacrylate which is hydrophilic in naturethus, polymerizes in the presence of water and forms a microporous hydrogel with pore size ranging from 10 to 100 nm.[(16)]Furthermore, it absorbs more water that acts as plasticizer within polymer matrix and leads to degradation of the filler‑matrix interface resulting in deterioration of mechanical or physical properties of cements.Another possible reason is the mode of application of the priming mixture,as it is a key factor for receiving high bond strength with Multilink N as Holdereggeetal[(17)]revealed that the mode of application of a priming agent is strongly influenced by the operator, and hence, these systems are technique sensitive. However, in contrast to Multilink N, Multilink Speed was least influenced by the operator, because it uses no priming systemso it is less technique sensitive.Nikaido et al. revealed that resin coating with a one-bottle adhesive improved the bond strength of resin cement[(18)].The result agreed with Guilardetal[(19)] that found that self-adhesive resin cement produced better results than the conventional cement with self-etching adhesive for the dentin surface with immediate dentin seal that cleaned with the dental excavator.The results agreed with Bila et al [(20)] results that showed higher increase in bond strength of self adhesive resin cement than conventional resin cement (etch and rinse /self etch) when immediate dentin seal has been applied and they recommended that self adhesive resin cement preferred as a luting cement for CAD/CAM restorationsThe results agreed with Bellanetal[(21)]who demonstrated that the self-adhesive resin cement did not differ from self etch and total etch resin cement aThe results disagreed with other studies Higashi([22)] who found that The μTBS values were higher for the total-etch than for the self-adhesive resin cement.pplication with CAD/CAM ceramic restoration.

In this study, values of bond strength results were less than that of previous studies. This might be because these previous studies performed bond strength test between composite or resin cement and ceramic material which was usually more than bond strength between dentin and ceramic, as achieving effective dentin bonding was much more challenging because it is a porous, moist tissue consisting of hydroxyapatite particles in a collagen protein matrix.[(23)]

V. CONCLUSION

Within the limitations of this in-Vitro study, it was concluded that;

1) Immediate dentin seal influence bond strength of lithium disilicate .

2) Different type of resin cement have similar effect on bond strength between dentin and lithium disilicate ,however self-adhesive more better effect and simple technique.

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