Bonding of Tooth Colored Restoratives to Er:YAG Lased Dentin

Thesis

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Materials and Method

I-Preparation of the samples:

Two hundreds of human molar teeth were extracted, from ٣٠ to ٤٠ years old patient, for periodontal diseases. The teeth were free of visible caries and other surface defects. Teeth were cleaned with a rotary brush and pumice and stored in saline no more than ٦ months from time of extraction to inclusion in the study.

The roots were sectioned ٢ mm beyond the cemento-enamel junction .Teeth were individually embedded in polyvinyl chloride cylinder (٢ cm diameter and ١,٥ cm high) filled with an auto-polymerized acrylic resin (JET, Cla´ssico, Sa˜o Paulo, SP ٠٥٤٥٨-٠٠١).

The occlusal enamel was removed by horizontal sectioning till reaching the dentin just below the dentinoenamel junction using the Isomet slow-speed diamond saw (Isomet ١٠٠٠; Buehler, Lake Bluff, IL, USA).

The dentin surface was abraded with decreasing grits of silicon carbide (SiC) paper (from #٨٠٠ to # ١٢٠٠) under water-cooling for ٣٠ s / paper. A standard superficial dentin surface of about ٠.٥ mm from dentinoenamel with standard smear layer was produced.

Dentin surface area for testing was determined with the aid of an adhesive tape punched by a modified Ainsworth

rubber-dam punch to provide ٣ mm diameter holes. This was necessary to ensure that the restorative material was applied to the tested areas [٤٩, ٥٧, ٥٩, ٦٤].

Fig (٣) Prepared samples

II-Sample classification:

The total two hundred samples were classified into two main groups:

Group I: one hundred samples for resin composite application [Composan LCM (PROMEDICA. No.٢٤٧٤ , Germany)].

Group II: one hundred samples for glass ionomer application [Medifil (PROMEDICA , Germany)]

Each group was subdivided into two subgroups:

Subgroup ١: ٥٠ samples were not pretreated with acid.

Subgroup ٢: ٥٠ samples were pretreated with acid.

Each subgroup was further divided into five divisions according to Er:YAG laser energy levels used:

Division ٠: no laser

Division ١: ٢٠٠ mJ Er:YAG laser

Division ٢: ٣٠٠ mJ Er:YAG laser

Division ٣: ٤٠٠ mJ Er:YAG laser

Division ٤: ٥٠٠ mJ Er:YAG laser

Thus, a total of two hundred samples were prepared for this investigation representing ١٠ samples of each condition. Each sample was tested for surface roughness and fracture bond strength.

Table(١) : Levels of the work design:

Variable	Sign	Condition
Restorative Material	**A**	**A ١**: Resin Composite **A٢**:Glass ionomer
Energy levels	**B**	**B٠**: no laser **B١**:٢٠٠ mJ **B٢**:٣٠٠mJ **B٣**:٤٠٠mJ **B٤**:٥٠٠mJ
Pretreatment condition	**C**	**C١**:dentin is not etched with phosphoric acid in case of composite and not conditioned with polacrylic acid in case of glass ionomer. **C٢**: dentin is etched with acid in case of composite and conditioned with polacrylic acid in case of glass ionomer
Sample group	X	١٠ Samples per experiment

Table (٢) Factorial design and variable interaction

A / B		A١		A٢		Total
		C١	C٢	C١	C٢	
	B٠	A١B٠C١ A١B٠C٢		A٢B٠C١	A٢B٠C٢	٤٠
	B١	A١B١C١ A١B١C٢		A٢B١C١	A٢B١C٢	٤٠
	B٢	A١B٢C١ A١B٢C٢		A٢B٢C١	A٢B٢C٢	٤٠
	B٣	A١B٣C١ A١B٣C٢		A٢B٣C١	A٢B٣C٢	٤٠
	B٤	A١B٤C١ A١B٤C٢		A٢B٤C١	A٢B٤C٢	٤٠
Total		٥٠	٥٠	٥٠	٥٠	٢٠٠

III- Laser ablation condition:

Dentin surfaces, to be exposed to laser, were ablated by Er:YAG laser device *. Its wavelength ٢,٩٤ µm in infra red region. Spot size was ٣ mm and pulse duration ٢٥٠µ m. The beam was applied perpendicularly to the specimens, with the tested different energy levels of (٢٠٠ , ٣٠٠ , ٤٠٠ , ٥٠٠ mJ).

*: BURANE XL Er:YAG laser ١٢٤٣, Germany.

A pulse repetition rate was ٤ HZ .The number of pulses delivered for each specimen was constant ٥٠ pulses as the duration was ١٢,٥ sec (Fig. ٤ &٥)

Fig. (٤) Er:YAG laser device

Fig. (٥) Laser application on the dentin surface

IV – Pre-treatment of Dentin surface:

A)Each division of group I samples [one hundred samples for resin composite application] were either : non etched (٥٠ samples) or etched (٥٠ samples) for ١٠ sec with etching agent(٣٥ % of phosphoric acid, Cica ,PROMEDICA, Germany) and rinsed for ٢٠ sec. Then oil free air dried.

A thin layer of the tested adhesive material (Compobond ١, PROMEDICA, Germany) was carefully applied ,to etched or non etched specimens ,on the limited dentin surface with disposable brush tips to avoid excess and pooling of adhesive along the edges of the insulating tape, which could compromise the distribution of fracture during the test . The specimen was gently air-dried for ٥s and photopolymerized for ٢٠ s using a light-curing unit [(XL ٣٠٠٠, ٣M Dental Products, USA)] with an output of ٤٥٠ mW/cm٢. The intensity of light was checked with a radiometer [Demetron/Kerr, Danbury, CT, USA] every five samples.

A circular Teflon matrix was positioned over the tested areas, resulting in a cylindrical cavity with the

diameter coincident with the determined bonding area (φ = ٣mm) and ٣ mm in height.

Resin composite(Composan LCM, PROMEDICA, Germany) was applied, in two successive layers and two curing times for ٤٠ sec, to the treated surface to give a disc of ٣ mm in width and ٣ mm in depth.

B) Each division of group II [one hundred samples for glass ionomer application] were either ,non conditioned (٥٠ samples) or conditioned (٥٠ samples) with dentin conditioner (١٠ % of polacrylic acid , ESPE D-٨٢٢٢٩ Seefeld , Germany).The conditioner was applied over the surfaces with a light scrubbing motion for ١٠ seconds and the specimens were then washed with distilled water for ٣٠ seconds and excess moisture was removed with absorbing paper.

For all the samples, non conditioned or conditioned, a circular Teflon matrix was positioned over the tooth, resulting in a cylindrical cavity with the diameter coincident with the determined bonding area (φ = ٣mm) and ٣ mm in height.

A standard, glass ionomer (Medifil, PROMEDICA, Germany), power/liquid ratio was then mixed as specified by manufacturer and applied to the dentin to give a disc of ٣ mm in width and ٣ mm in depth.

Table ٣ Tested restorative materials:

Material/Manufacturer		***Composition***	***Ratio (g)***
Resin Composite (PROMEDICA)	Adhesive resin (Compobond ١)	BIS-GMA, HEMA ,BHT, acetone & organic acid	
	Hybrid resin composite (Composan LCM)	٧٦,٥ % by wt inorganic filler , microfiller ~ ٠,٠٥μm & small particles ~ (٠,٠٥-٢μm)	
Medifil , PROMEDICA ,(glass ionomer filling material)		**Powder**: fluorosilicate glass particles **Liquid**: water, polyacylic acid ,PHB- ester	٤,٧-٥,٦ g **P** : ١ g **L**

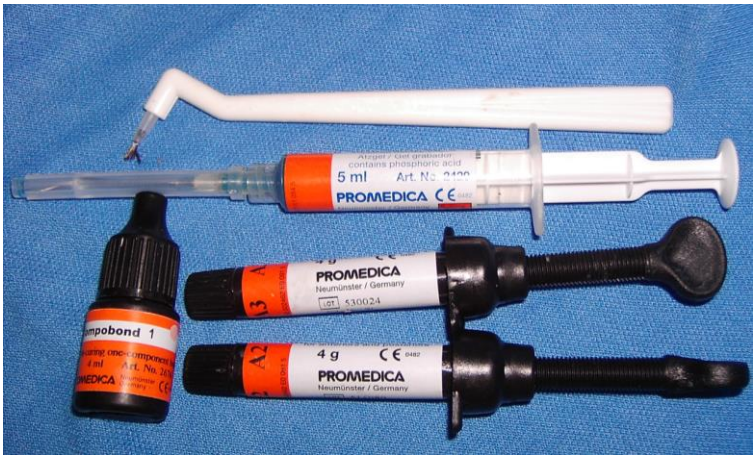

Fig. (٦) Resin Composite material

Fig. (٧) Glass ionomer restorative material

V- Measurement of surface roughness:

Five points were determined on each sample for measuring of the surface roughness of the dentin for all groups. These points were one on the upper part of the tested area, one in the lower part, one on the right part, one on the left part and one on the center.

Dentin roughness was tested using a profilmeter*. The profilmeter which is based on a diamond tracer of ٠,٥ μm in diameter was adjusted to traveling distance of ٠,٨. It is based on measuring the Ra value which is the arithmetic mean of the movement of the profile above and below the central line of the surface. The mean of five tracing for every specimen was calculated and taken as the surface roughness value of the specimen. Dentin roughness was measured for all samples before laser ablation, after laser ablation, after pretreatment of the dentin surfaces.

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*: TR ١٠٠ surface roughness tester Time group Inc.USA.

Fig. (٨) TIME surface roughness tester

VI- Measurement of shear bond strength:

The samples of each group were subjected to shear bond strength testing. The samples with their restorative material were clamped to a universal testing machine***(fig . ٩) . Each specimen in its resin block was hold in the lower jaw of the testing machine. In the upper jaw, a knife edge chisel was attached and allowed force application on interface between the test material and the tooth surface(fig . ١٠)the test machine was run at a constant speed of ٠,٥ mm/min and until the restoratives fracture. The software windap version ٣,٢ on IBM compatible computer connected to the machine was used to collect data and draw a load-displacment curve for each specimen. Shear bond strength values were registered in Newton and transformed into MPa by dividing the maximum load by the surface area .

The surface area was calculated according the equation:

$A = \pi r^{٢}$, where

$\Pi = ٢٢/٧ = ٣,١٤$

r = ١,٥ mm so

$A = ٢٢/٧ \text{ X } (١,٥)^{٢} = ٧,٠٦٥ \text{ mm}^{٢}$.

***: LLOYD Universal Testing Machine. Lloyd Instrument LR٥R series UK