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Shear bond strength of posterior comp-osite cores

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ABSTRACT

This study was designed to evaluate the shear bond strength (SBS) of posterior composite resin cores to tooth surface using two dental adhesives and two retentive means.

Thirty extracted permanent molars were used for this purpose. They were made flat by removing the occlusal one third using "stone grinding wheel". Teeth were then randomly divided into six groups:

Groups I and IV: Scotchbond Multipurpose Plus (SbMP) and All bond 2 dental adhesives were used for groups I and IV respectively to adhere composite to the flat tooth surface with no retentive mean as the control group.

Groups II and V: A circumferential slot was prepared and composite attached to the tooth using SbMP and All bond 2 for groups II and V respectively.

Groups III and VI: Four self threading pins were placed and composite adhered using SbMP and All bond 2 for groups III and VI respectively.

After storage and thermal cycling, the SBS for each group was measured using "universal testing machine".

The results varied according to the retentive mean and dental adhesive used. Groups with four pins produced the highest SBS and groups with no retentive mean showed the lowest SBS. Also the groups using All bond 2 adhesive generally had higher values when compared with the same groups using SbMP dental adhesive.

Within the limits of this study, it is indicated that when the highest SBS is to be achieved, then All bond 2 dental adhesive with pins should be used.

Key Words: Shear strength, composite cores.

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INTRODUCTION

More than 40 years ago, Bowen(1) introduced a new restorative material called composite resin to the dental profession. Almost at once, it replaced silicate cement and its immediate predecessor, acrylic resin. The ra-pid acceptance of composite resin by organi-zed dentistry was based on several important considerations. These included its excellent colour matching ability; substantially impro-ved physical properties; and the relative ease of handling. These improved properties res-ulted from the incorporation of high levels of ceramic filler particles into a strong wear resistant resin matrix.[2]

First generation, composite materials consisted of a separate base and catalyst co-mponent, which were mixed together, prod-ucing a chemical reaction that provided for a process of auto–po1ymerization.[3]

The first composite resin chemically adhesive to both enamel and dentin was dev-eloped in 1977.[4] Dentin bonding agent is now used routinely to provide retention for composite restoration.[5] Dentin bonding sys-tems should provide a strong early bond bet-ween resin and dentin to resist the polymeri-zation shrinkage of the resin composite and prevent microleakage around the restora-tion.[6] Dental resin composites, specifically advocated for use in the posterior teeth, were introduced in the early 1980s, and have be-come increasingly popular in restorative dentistry.[7] The first major improvement in posterior composite resins came about with the introduction of a restorative material cal-led p–10 (3M Co, USA). Interestingly this material was a simple modification of a rest-orative material called Concise, which was marketed by the same company (3M Co, USA) for anterior teeth.[8]

Several methods have been advocated for rebuilding fractured or mutilated teeth before preparation for and fabrication of cast restorations. The most frequently used core materials in these techniques are cast metal, amalgam, cement, and composite.[9] The res-ult from a survey of dentists indicated that composite has become one of the most fre-quently used core materials for building up worn–down teeth before preparation for cast restorations. Its rapid rate of polymerization allows a dentist to build up a tooth, prepare it for a cast restoration, and make an impres-sion at one appointment.[10]

The aim of the present study was to evaluate the shear bond strength (SBS) of two dental adhesives with two retentive me-ans used to adhere composite cores to the tooth surface.

MATERIALS AND METHODS

Thirty freshly extracted intact human permanent molar teeth were collected from private clinics and the health centers in Mo-sul City. All teeth were cleaned with non–fluoridated pumice and rubber cup, and exa-mined for crack presence by using fiber–optic light (Quayle Dental Co, England). The teeth were stored in distilled water at ro-om temperature until the time of experiment. They were embedded in brass cylinders of 20mm height and 12mm diameter using aut-opolymerizing acrylic resin (Quayle Dental Co, England). Then the occlusal one third of the crowns of all teeth was ground by water cooled trimmer “stone grinding wheel” (Yoshida Dental Co, Japan), to expose flat dentin surface perpendicular to the long axis of the teeth (Figure 1).

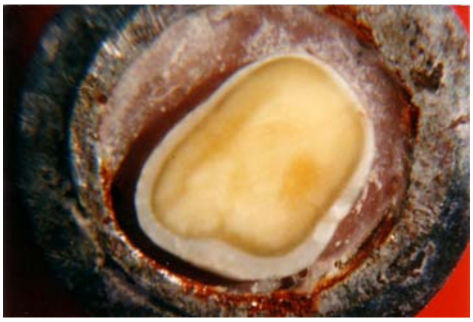

Figure (1): Flattened occlusal tooth surface

The surface area of each specimen was calculated by using planometer (Gordia AG, Zurich, Swiss). The surface area of each spe-cimen was obtained in cm^2. This surface area includes both enamel and dentin beca-use it is difficult to measure them separately. A transparent elastic ring was used on each specimen to make a composite core of 4mm in height. The ring was placed so that it will engage the external tooth surface tightly (Figure 2).

Before tooth surface conditioning, all the teeth surfaces were repolished with 600 grit abrasive papers to create fresh smear la-yer.[11] The surfaces of specimens were rins-ed and gently air–dried.

Specimens were then randomly assign-ed into six groups:

<u>Group I and group IV:</u>

Dental adhesive Scotchbond Multipur-pose plus (SbMP) (3 M Co, USA) was used for group I according to manufacturer’s inst-ructions and All bond 2 (Bisco Co, Itasca, USA) was used for group IV according to manufacturer instructions. In both groups, no retentive mean was used and the composite attached directly to the tooth surface using the aforementioned adhesives.

Figure (2): Elastic ring engaging the tooth

Group II and Group V:

A circumferential slot 0.5 mm in depth and 0.5 mm in width was prepared with quarter round bur about 0.5–1 mm from dentino–enamel junction (DEJ) on each specimen (Figure 3). Then SbMP dental adhesive was used for group II and All bond 2 dental adhesive was used for group V.

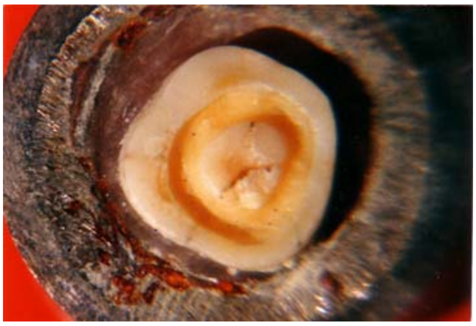

Figure (3): Prepared slot

Group III and group VI:

Four pins (Quyale Dental Co, England) were seated on every tooth, each pin under each cusp tip, about 1–1.5 mm from DEJ (Figure 4). Then SbMP dental adhesive was used for group III and All bond 2 dental adh-esive was used for group VI. Upon comple-tion of the above procedures, a composite core of 4mm in height was built on each specimen by using Z100 composite (3M Co, USA). It was placed in two increments of 2 mm thickness, each increment light cured for 40 seconds. When build up was comple-te, the composite resin was then light cured for 40 seconds from all directions to ensure complete polymerization of the core. The sp-ecimens were then returned back to distilled water. After 24 hours all 30 specimens were subjected to manual thermal cycling of 100 cycles at 55±2 ºC and 4±2 ºC.[12, 13]

Figure (4): Four pins seated in place

After one week of storage in distilled water at room temperature,[12] the bond strength between composite and tooth structure was measured in shear mode by using universal compression machine (Electric Unconfined Compression Apparatus, Soit Test Co Inc, USA), at a cross head speed of 0.5mm/min.[13]

The mode of failure was tested by using visual examination and a magnifying lens for all specimens.

Statistical analysis of data included one–way analysis of variances (ANOVA) and Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

The average surface area of the teeth measured between 0.7 to 0.85 cm². The ANOVA is given in Table (1). The results revealed that there was significant difference in the mean SBS among various groups at p<0.01. Duncan's Multiple Range Test at p<0.01 was used to select the best mean(s) among groups.

Table (1): Analysis of variance for shear bond strength of all groups

	df	SS	MS	F–value
Treatments	5	439.324	87.8648	60.31*
Error	24	34.964	1.468	
Total	29	474.288		

df: Degree of freedom, SS: Sum of squares, MS: Mean square.

*Significant at 0.01 level of probability.

The results showed that group VI (pins with All bond 2 adhesive) possess the highest mean (33.32 MPa), and group I (flat surface with no retentive mean) possess the lowest mean (21.48 MPa). The results also indicated that there was a significant difference between the mean of group I and the means of other groups, and also between the mean of group VI and the means of other groups, but there was no significant differen-ces between the means of groups II and IV and between the means of groups III and V (Table 2).

Table (2): Duncan's Multiple Range Test for shear bond strength of all groups

Group	Mean + SD	Duncan's Grouping*
I. SbMP	21.48 + 1.258	D
II. SbMP + Slot	24.30 + 2.068	C
III. SbMP + Pin	29.20 + 0.800	B
IV. All bond 2	25.02 + 0.832	C
V. All bond 2 + Slot	28.20 + 0.903	B
VI. All bond 2 + Pin	33.32 + 0.858	A

*Groups with the same letter are not significantly different.

In this study, it was noted that when two types of bonding systems were used with mechanical retention means, the SBS of composite core increased gradually from slot to pin. This result agreed with Tjan *et al*.,[14] who revealed that the fracture strength of composite cores retained by 4 retentive pins was significantly higher than those retained by slots or channels. Also the type of bond-ing system used affects the retention value. The specimen with All bond 2 showed SBS values greater than specimens with SbMP dental adhesive. This result disagreed with Ateyah and Elhejazi,[15] who showed that SBS of SbMP (13.72 MPa) was significantly higher than that of All bond 2 (6.85 MPa).

This study also revealed that the SBS of all specimens were within the value given by the manufacturer (24 MPa for SbMP and from 15–40 MPa for All bond 2 dental adhesives).

The mode of failure for all groups were cohesive type (tooth fracture) and the composite remains attached to the tooth surface (Figures 5, 6 and 7). This indicated the high bond strength when using those types of adhesives (SbMP and All bond 2). However, the combination of adhesive and pins showed the highest SBS.

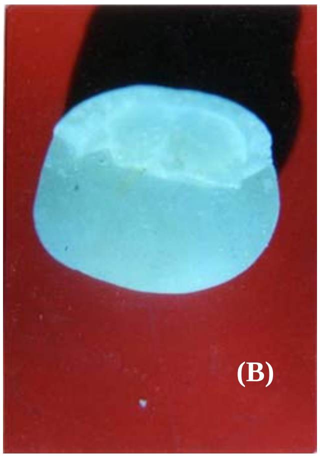

Figure (5A and B): Example of cohesive fracture

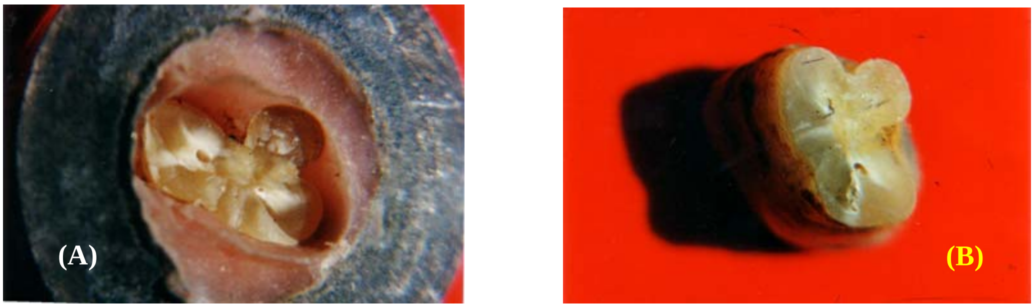

Figure (6A and B): Cohesive fracture extending into the root

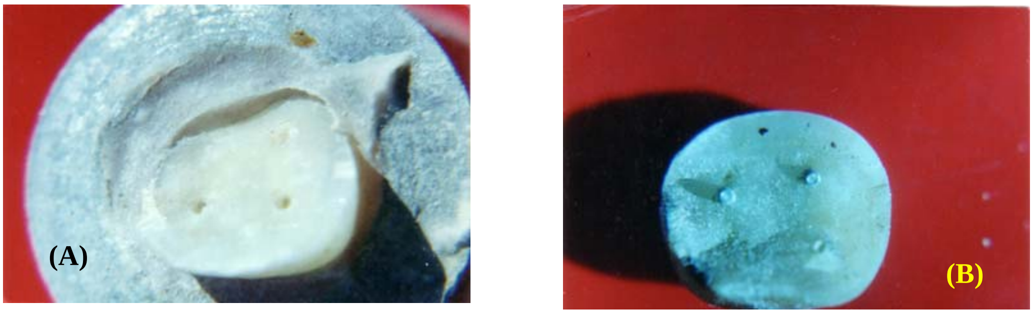

Figure (7A and B): Cohesive fracture with pin group

CONCLUSIONS

The highest SBS values were recorded for groups with four pins, and the lowest for groups with no retentive mean (flat tooth surface) regardless of the dental adhesive used. Groups with retentive slot showed intermediate SBS values, also regardless of the adhesive used. When failure modes were considered, they were all of cohesive type, indicating the high bond strength of the two bonding agents used. Meanwhile, the SBS values for All bond 2 adhesive were generally higher than those recorded for SbMP adhesive.

REFERENCES

1. Bowen RL. Properties of a silica–reinforc-ed polymer for dental restorations. *J Am Dent Assoc*. 1963; 66: 57-61.
2. Philips RW, Avery DR, Swartz ML, Mc-Cune RJ, Mehra R. Observation on a com-posite resin for class II restorations: 2 years report. *J Prosthet Dent*. 1972; 28(2): 164-169.
3. Clemens A, Hollander WR. The composite resin restoration: A literature review part III: What the future holds. *J Dent Child*. 1993; 60: 331-345.
4. Fusayama T, Nakamura M, Kurosaki N, Iwaku M. Non–pressure adhesion of a new restorative resin. *J Dent Res*. 1979; 58: 1364-1370.
5. Butchart DGM, Kamel JH. Retention of composite restoration. A comparison betw-een a threaded pin and a dentine bonding agent. *Br Dent J*. 1988; 165: 217-219.
6. Price RBT, Hall GC. In vitro comparison of 10 minutes versus 24 hours shear bond strength of six dentin bonding system. *De-nt Mater*. 1999; 30(2): 122-134.
7. Christensen GH. Acceptability of alterna-tive for conservative restoration of posteri-or teeth. *J Esthet Dent*. 1995; 7: 228-232.
8. Leinfelder KF, Wilder ADJr, Teixeira

LD. Wear rates of posterior composite resin. *J Am Dent Assoc*. 1986; 112(6): 829-833.
9. Netti CA, Cunningham DE, Lotter GH. Tensile strength of composite core mater-ials containing added colorants. *J Prosthet Dent*. 1988; 59(5): 547-552.
10. Oliva RA, Low JA. Dimensional stability of composite used as a core material. *J Pr-osthet Dent*. 1986; 56(5): 554-561.
11. Mowery ASJr, Parker M, Davis EL. Den-tin bonding: The effect of Surface rough-ness on shear bond strength. *Oper Dent*. 1987; 12: 91-94.
12. Eakle WS, Staninec M, Yip RL, Chares MA. Mechanical retention versus bonding of amalgam and gallium alloy restorations. *J Prosthet Dent*. 1994; 72: 351-354.
13. Ratananakin T, Denehy GE, Vargas MA. Effect of condensation technique on amal-gam bond strength to dentin. *Oper Dent*. 1996; 21: 191-195.
14. Tjan AH, Dunn JR, Lee JK. Fracture resis-tance of amalgam and composite resin cor-es retained by various intradentinal reten-tive features. *Quintess Int*. 1993; 24(3): 211-217.
15. Ateyah AZ, Elhejazi AA. Shear bond stre-ngths and microleakage of four types of dentin adhesive materials. *J Contemp Dent xPract*. 2004; 5(1): 63-73.