

## The Fracture Resistance Of The Endodontically Treated Molar Teeth With MOD Preparations Restored With Different Types Of Composit Material.

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### الخلاصة

عند المقارنة بالأسنان الصحيحة فإن الأسنان المعالجة جذرياً أكثر عرضة للكسر، واجريت هذه الدراسة لإثبات تأثير استعمال حشوة الكومبوزت نوع الانسيابي (flowable) بوجود أو عدم وجود ألياف البولي اثيلين المدعمة على عامل مقاومة الكسر للأسنان المعالجة جذرياً نوع الطواحن. ثلاثون طاحن سفلي صحيح مقلوع ، قُسمت عشوائياً إلى ثلاث مجاميع (n=10) المجموعة الأولى :- يُرمم باستخدام الرابط مع حشوة الكومبوزت .  
المجموعة الثانية :- رُمم بطبقة من النوع الانسيابي (Plowable) قبل حشوة الكومبوزت المجموعة الثالثة :- أُستخدم فيها الياف شريط البولي اثيلين، التي وضعت في الحفر من الاتجاه الخدي إلى اللساني. بعد ذلك العينات حُزنت في 100% رطوبة بدرجة 37م ليوم كامل. ثم قيست باستخدام ماكنة القياس العالمية بسرعة  $0.5\text{mm min}^{-1}$  القوة اللازمة لكسر العينة سُجلت بـ Newtons (N) ثم حُللت إحصائياً النتائج بينت ان استعمال النوع الانسيابي للكومبوزت ليس له تأثير كبير على عامل مقاوم الكسر للأسنان المعالجة جذرياً بينما استعمال النوع الانسيابي للكومبوزت مع ألياف البولي اثيلين يزيد من عامل المقاومة للطواحن السفلية المعالجة جذرياً.

### Abstract

Compared to teeth with healthy pulps, root filled teeth are considered more susceptible to fracture.

The present study was directed toward improving the effect of using flowable composite with or without polyethylene fiber reinforcement on fracture resistance of the endodontically treated mandibular molars with MOD preparations.

Thirty sound extracted human mandibular molars were randomly assigned to three groups (n=10). All teeth were root filled and MOD cavity preparation were created.

Group (1) was restored with a dentine bonding system(DBS: SE Bond) and composite resin( CR).

In group (2), flowable composite resin ( Protect liner F) was used before restoring teeth with CR.

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**In group (3)** leno woven ultra high modulus polyethylene ribbon fiber ( Ribbond, Seattle, WA. USA) was inserted into the cavities in a buccal to lingual direction and teeth were then restored with DBS and CR. After finishing and polishing the specimens were stored in 100% humidity at 37C° for 1 day. Compressive loading of the teeth was performed using a universal testing machine at a crosshead speed of 0.5 mm min<sup>-1</sup> . the mean load necessary to fracture the samples were recorded in newtons (N) and were subjected to analysis of variance (ANOVA) and Tukey test.

The results showed that the used of flowable composite resin under composite restorations had no effect on fracture resistance of root filled molars teeth with MOD preparation . while the used of polyethylene fiber under composite restorations in root filled teeth with MOD preparations significantly, increased fracture strength .

### **Aim**

To evaluate the effect of using flowable composite with or without ultra high modulus polyethylene fiber reinforcement on fracture resistance of root filled mandibular molars with mesio -occluso-distal(MOD) preparations.

### **Introduction**

Restoration of root filled molars is a challenge. Sound tooth structure removed during cavity preparation influences its strength and ability to resist loading (1).

Compared to teeth with healthy pulps, root filled teeth are considered more susceptible to fracture as they possess reduced dentinal elasticity, lower water content(2), deeper cavities, and substantial loss of dentine<sup>(3)</sup>. Root canal treatment should not be considered complete until the coronal restoration has been placed. Previous studies indicated that complete cast coverage, an indirect cast restoration covering the cusps (4), complex amalgam restorations (5) or composite materials can be used for final restorations. With recent advancements in adhesive technology and new and stronger composite materials, it is possible to create conservative, highly aesthetic restorations that are bonded directly to teeth. However, polymerization shrinkage remains a problem for extensive direct composite restorations(6). As polymerization shrinkage is compensated by flow of composite (7), a rigid bond between resin composite and tooth structures generates contraction stresses at the bonding interfaces(2,6). These stresses can be reduced by several methods. Dentine bonding agents are assumed to resist

the contraction forces by forming a continuous hybrid layer between the restoration and tooth structure(5).

The hardness and elasticity of the resin-dentine bonding area using nanoindentation and the layer of collagen fibrils densely packed with resin may act as an inherent elastic buffering mechanism to compensate for the polymerization contraction of the restorative resin(8). One of the methods suggested for reducing debonding during polymerization shrinkage is the application of a low viscosity, low modulus intermediate resin between the bonding agent and restorative resin to act as an( elastic buffer) or (stress breaker) that can relieve contraction stresses and improve marginal integrity(7,9). However, flowable composite did not produce gap-free resin margins in Black II slot cavities(7).

The development of fiber-reinforced composite(FRC) technology has increased use of composite resin materials in extensive preparations. FRC has been used in the laboratory for fabrication of single crowns, full and partial coverage fixed partial dentures, fabrication of periodontal splints and chair side fixed partial dentures(10). FRC has been shown to possess adequate flexure modulus and flexural strength to function successfully in the mouth(11).

### **Material and Methods**

Thirty freshly extracted human mature mandibular molar teeth with similar dimensions and without caries, abrasion cavities and injury from forceps or fractures were used. The teeth were cleaned of debris and soft tissue remnants and were stored in physiological saline at +4C° until required. The 30 teeth were randomly assigned into three groups of 10 teeth each and were prepared as follows

Access cavities were prepared using a high-speed bur and water spray and the canals were instrumented with K files to an apical size 35 using the stepback technique. Irrigation with 2 mL of 5.25% NaOCl preceded each file introduced into the canal.

Following biomechanical preparation, canals were dried with absorbent paper points and obturated with gutt-percha and AH Plus sealer using cold lateral condensation. MOD cavities were prepared in the teeth down to the canal orifices so that the thickness of the buccal wall of the teeth measured 2 mm at the buccal occlusal surface, 2,5 mm at the cemento-enamel junction and that of lingual wall measured 1.5 mm lingual occlusal surface, 1.5 mm at the cemento-enamel junction(figure-1).

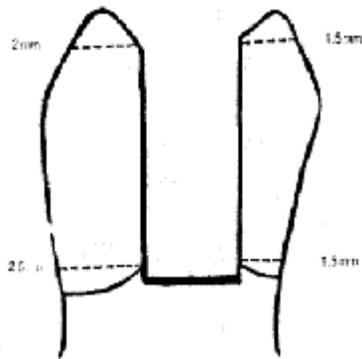


Figure 1 The schematic representation of MOD cavity in molar teeth.

The teeth were then embedded in self-curing polymethylmethacrylate resin to the level of the cemento-enamel junction.

### Group 1

The cavities were cleaned and dried. After priming for 20 s., the cavity surface were gently dried. SE Bond was applied to the cavity surfaces and cured for 20 s., The cavities were then restored with a resin composite using a bulk technique and cured for 40 s. ( figure-2).

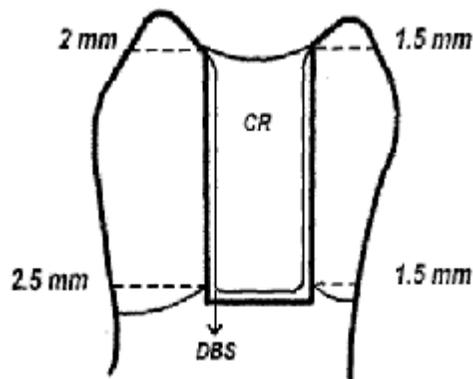


Figure 2 The restoration of teeth in group 1 with DBS and CR.

### Group 2

After priming and bonding procedures as in group(1), the cavity surfaces were coated with a layer of low viscosity resin composite (flowable composite resin ,FCR) and cured for 20 s. this low modulus liner was then covered with me same resin composite using a bulk technique as described in group(1) (figure-3).

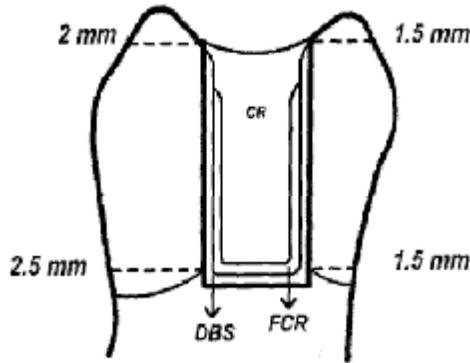


Figure 3 The restoration of teeth in group 2 with DBS and FCR and CR.

**Group 3**

After priming and bonding procedures as in group 1, the cavity surfaces were coated with flowable composite as in group (2). Before curing, a piece of LWUHMW polyethylene fiber ( 8mm long, 3 mm width) was cut and coated with adhesive resin. Excess material was removed and the fibre embedded inside the flowable composite in a buccal to lingual direction (figure-4 A,B).

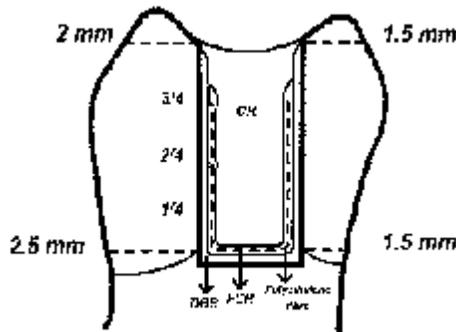


Figure 4 (A) The schematic representation of teeth restored in Group3 .

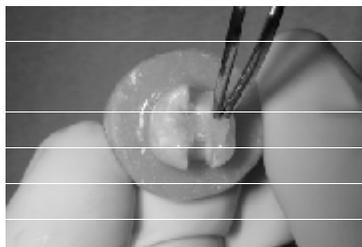


Figure 4 (B) The application of 3mm width polyethylene fibre with flowable composite resin from buccal to lingual direction.

After curing for 20 s. the cavities were restored with composite as described above.

Then storing in an incubator at 37 C° in 100% humidity for 24 h, the specimens were placed into a Universal Testing Machine (Baghdad) and loaded compressively at 0.5 mm min<sup>-1</sup>. compressive force was applied with a 5-mm diameter stainless steel bar. In all cases the force was applied to the occlusal surface of the restoration touching buccal and lingual cusps of the teeth. The force necessary to fracture each tooth was recorded in newtons (N) and the data were subjected to a one-way analysis of variance (ANOVA) and Tukey HSD test for the four experimental conditions.

## **Results**

The minimum, maximum and mean fracture resistance (N) and the standard deviation for each of the four experimental conditions are presented in table (1).

One-way ANOVA indicated that the fracture strength of group 1 was significantly lower than the other groups(  $p < 0.05$ ). Use of flowable composite resin under the composite resin ( group 2) did not increase fracture resistance in root filled teeth ( $p < 0.05$ ). Inserting a piece of LWUHMW polyethylene fiber in a buccal to lingual direction under resin composite restoration ( group 3) significantly increased fracture strength of molar teeth with MOD preparations ( $p > 0.05$ ).

**Table (1): Minimum, maximum and mean fracture resistance (N) and the standard deviation for each of the five experimental conditions.**

Groups	Cavity	Restoration type	n	Minimum	Maximum	Mean ± SD
Group1	MOD	DBS + CR	10	611.50	988.10	745.22± 133.33 c
Group2	MOD	FCR+DBS + CR	10	690.70	914.00	785.48 ± 145.34 c
Group3	MOD	polyethylene fibre + FCR + DBS +CR	10	833.66	1099.20	987.36 ± 121.15 d

## **Discussion**

Restoration of teeth is an important final step of root canal treatment. The purpose of a restoration is not only to repair the tooth, but also to strengthen the tooth and provide an effective seal between the canal system and mouth.(1)

Reinforcement of the cavity with a restorative material is necessary to support the remaining tooth structure. Some studies have found that bonded composite restorations will strengthen a tooth when compared with amalgam (5) whereas others have been unable to show a difference (3).

Adhesive restorations better transmit and distribute functional stresses across the bonding interface to the tooth with the potential to reinforce weakened tooth structure(6).

Trope et al.(1986) showed that the resistance to fracture of tooth increased significantly when MOD preparations were acid-etched before restoration with a composite resin(12).

Kiremitci et al. (2003) reported that teeth restored with packable composite resin had the highest resistance to fracture when compared with amalgam(9).

When restoring with composite, many factors may affect the resistance of a tooth to vertical and/or cuspal fracture, such as cavity dimension(6). An extensive cavity can be restored using composite, however, the polymerization reaction of light stresses when the composite resin is bonded to the cavity walls. Joint et al.(1987) suggested that the fracture resistance of premolar teeth with MOD cavity preparations restored with composite resin may increase if an incremental resin placement and curing method is used. Against the widely accepted believe that incremental composite placement results in reduced stress buildup at the tooth-restoration interface (13).

Versluis et al(1996) reported that theoretically bulk filling generate less volumetric shrinkage within identical cavity shapes. Although layering concepts have been described as mandatory when working with resin-based composites. The effect of layering technique was eliminated and bulk technique was used in this study to evaluate the stress modifying effect of the flowable composite lining with or without fiber insertion( 14).

High viscosity bonding agents may also provide a layer of substantial thickness that acts as a stress absorber(8)and flow of the composite may release contraction stresses (7). An advantage of bonding, coupled with composite core build-up, is the high bond strength to tooth structure and increased resistance to fracture (2).

Hurmuzlu et al.(2003) compared the effect of six different DBS on fracture resistance of teeth and showed that the type of DBS had no influence in the fracture resistance of teeth(15).

In the present study, it was hypothesized that covering the surface with flowable composite or the addition of an LWUHMW polyethylene fiber before restoring teeth with resin composite would provide an increase in fracture strength. This was theorized on the concept that the presence of the glass or polyethylene network would create a change in the stress dynamics at the restoration/adhesive resin interface. This hypothesis was demonstrated in the LWUHMW polyethylene fiber group as inserting a piece of fiber in a buccal to lingual direction significantly increased fracture strength of root filled molar teeth with MOD preparations. The elastic modulus of polyethylene fiber with adhesive systems was previously measured by Eskitascioglu et al.(2002). The higher modulus of elasticity and lower flexural modulus of the polyethylene fiber might have a modifying effect on how the interfacial stresses are developed along the restoration/tooth interface(16).

Haller et al. (1991) reported a reduction of the bond strength to dentine of some adhesive systems when applied to 3D cavities in comparison with flat surfaces(17). In the present study, MOD preparations were used. The results may be different if flat surfaces were used. On the contrary, lining the cavity surfaces with flowable composite did not change the fracture strength. The thickness of the elastic layer created by flowable composite might not be enough to compensate contraction stresses inside an MOD preparation or the physical properties of an LWUHMW polyethylene fiber might have a positive effect on distributing stress along the restoration-tooth interface.

This study was carried out in (vitro) condition and the test was performed 24 h after restoration. The thermal, chemical, and physical stresses that the restoration could be subjected to over a longer period

In (vivo) may adversely affect the results, therefore further investigation is necessary to predict the in vivo behavior of this type of restoration.

## **Conclusions**

Within the limits of this study, it can be concluded that:

- Use of flowable composite under composite restoration had no effect on fracture resistance of root filled molar teeth that had been restored with composite resin.
- Inserting an LWUHMW polyethylene ribbon fiber in root filled molar teeth with MOD preparation significantly increased fracture strength.

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