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# "An in vitro evaluation of the fracture resistance of endodontically treated single rooted premolar fractured vertically and reattached using two different fiber reinforced composites"

KEYWORDS: vertical root freacture,polyethylene fiber,interlig fiber

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**ABSTRACT** *A vertical root fracture (VRF) manifests as a complete or incomplete fracture line extending obliquely or longitudinally through the enamel ,dentin and cementum of an endodontically treated teeth*

*THE AIM of this in vitro study was to determine the effect of two different types of fibers –ultra high molecular weight polyethylene and glass fiber on the fracture resistance of vertically fractured and reattached fragments of endodontically treated teeth. MATERIAL AND METHOD -Sixty single rooted mandibular premolar teeth extracted was collected and used in the study .vertical fracture was generated using chisel and mallet . Group1 ie control group consist of 15 obturated teeth without vertical fracture .Group 2 consist of vertically fractured teeth reattached using self adhesive resin cement, Group 3 consist of vertically fractured teeth reattached using polyethylene fiber ribbond THM, Group 4 consist of reattached using interlig glass fiber. The Teeth were subjected to vertical loading in universal testing machine and mean load needed to fracture the tooth were calculated .statistical analysis were done using ANOVA . RESULTS - The mean load required to fracture the tooth was highest for control group that is group 1 followed by group 3 which is reinforcement with polyethylene group and lowest for group 2 which is reinforcement with self adhesive resin cement and group 4 which is the glass fiber group.CONCLUSION reinforcement with polyethylene fiber (ribbond THM) increases the fracture resistance under vertical forces when compared to glass fiber reinforcement (interlig ).*

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**Introduction**

Vertical root fracture is an important clinical problem , it is the second most frequent identifiable reason for loss of endodontically treated teeth[1]. The reported prevalence of vertical root fractures (VRFs) in various populations is between 2 and 5%, based on case reports [2]. According to American Association of Endodontists, vertical root fracture (VRF) is defined as "A longitudinally oriented fracture of the root that originates from the apex and propagates to the coronal part"[3].Endodontically treated teeth are structurally weak and brittle due to extensive loss of tooth structure, excessive root canal preparation, over preparation of post space, prolonged use of chemical agents and moisture loss making them more prone to fracture. Earlier extraction was the only treatment of choice for a vertical root fracture but nowadays various treatment modalities have been suggested to save the tooth. In multirooted teeth , a fractured root can sometimes be amputated and the other root retained with a new coronal restoration whereas for a single rooted teeth the fractured fragment can be reattached extra orally with adhesive resin cement and reimplantated back into the socket[4].

The strength of the resin cement can be improved by placement of fibers along with adhesive resins. The fibers added to the polymer matrix provide high-impact resistance, increases the fatigue resistance and improves the stress distribution. currently the most popularly used fibers are ultrahigh molecular weight polyethylene and glass fiber[5]. However the effect of these two fibers have not been tested on the reattachment of vertical root fracture.

Dual cure resin Clearfill SA(clearfil S A,kuraraycompany) was used in this study instead of 4-META /MMA-TBB because 4-META /MMA-TBB resin used in past in vivo studies was reported to have difficulties in polymerization control . In addition dual cure resin has advantages such as polymerization control , easy application and short curing times[6] .

Ribbond-THM( ribbondTHM,ribbondinc company) Made from thinner fibers with a higher thread count, the leno woven Ribbond-THM has a higher modulus of elasticity than the Ribbond-Original and is only 0.18 mm thick[7] .

Interlig( interlig ,angleus company) is a structure of intertwined glass fiber impregnated with light cured composite resin having thickness o.2 [8]

Therefore the main aim of this study is to evaluate the influence of self adhesive resin cement along with two different fibers ribbond THM a polyethylene fiber ,interlig a glass fiber on the fracture resistance of vertically fractured and reattached fragment of an endodontically treated single rooted premolar .

**MATERIAL AND METHOD**

**Preparation and grouping of the specimens**

Sixty single rooted mandibular premolar teeth extracted was collected and used in the study . Access cavity was prepared with Endo access bur followed by working length determination 1mm short of the apical foramen. Cleaning and shaping of the canal was done .The canal was enlarged up to 40 K file and a step back upto 60 K file was done . Fifteen teeth was obturated with 40 size gutta-percha cone coated with AH plus sealer was inserted and accessory gutta-percha cone was placed with the aid of finger spreader under active lateral condensation and

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used as control group.

**Control group 1 : consist of 15 endodontically treated obturated teeth.**

**GENERATING VERTICAL ROOT FRACTURE:**

Forty five endodontically treated instrumented teeth were fractured by placing a groove of about 0.5mm in the middle of the tooth mesio-distally using diamond disc in a high speed hand piece and air water spray . A tapered chisel was placed in the groove and mechanical force was applied using mallet until the tooth fractured. The teeth were separated corono-apically equally into two fragments and was selected and used in this study.

**DIVISION OF EXPERIMENTAL GROUPS:**

Forty five endodontically treated fractured teeth without obturation was separated equally and divided into three groups each consisting of fifteen teeth.

GROUP 2 : consists of fifteen teeth whose reattachment of fractured fragment was done using dual cure resin cement (clearfil S A,kuraraycompany) .

GROUP 3: consists of fifteen teeth whose reattachment of the fractured fragment was done using dual cure resin cement reinforced with ultrahigh molecular weight polyethylene fibers( ribbondTHM,ribbondinc company) 0.18mm in thickness and 2mm width.

GROUP 4: consist of fifteen teeth whose reattachment of the fractured fragment was done using dual cure resin reinforced with silinated cold gas plasma treated glass fiber ( interlig ,angleus company).0.2mm in thickness and 2mm in width.

Excess resin cement was removed using a periodontal curette .All the samples were light cured for 20 sec .The sample was stored in a plastic dispenser with gauze at the bottom moistened with water generating a moist environment to prevent dehydration of teeth for one week. All samples were prepared to test its fracture resistance using an universal testing machine..Statistical analysis of the mean load was calculated using Kruskal-wallis test and one way ANOVA .

**Results**

**Table 1 about here**

**Table 2 about here**

**Table 3 about here**

According to table 2 of result the mean load required to fracture the tooth was highest for control group that is group 1 followed by group 3 which is reinforcement with polyethylene group and lowest for group 2 which is reinforcement with self adhesive resin cement and group 4 which is the glass fiber group .

According to table 4 of result there existed a statistically significant difference between group 1 and all the other groups and within the groups group 3 showed statistically significant difference between group 2 and group 4 . but between group 2 and 4 even though group 4 showed a increase in the fracture resistance load it was statistically insignificant .

**DISCUSSION**

Endodontic procedures including preparation of access cavity remove sound tooth structure which may severely affect the strength and integrity of a tooth. In addition, intra canal preparation with instruments such as gates glidden burs and various files will further remove tooth structure[9]. Treatment of vertically fractured teeth is difficult and dependent on the tooth type as well as on the extent, duration and location of the fracture. The constant ingress of bacteria in to VRF's provides an open pathway from the oral cavity to the supporting periodontal tissues leading to bone loss. The aim of treatment is therefore to eliminate the fracture or the leakage of bacteria along the fracture plane[3].

An earlier study reported short-term prognosis of intentional replantation of vertically fractured roots reconstructed with dentin-bonded resin . The longevity of vertically fractured roots treated by intentional replantation after reconstructing with dentin-bonded resin was calculated as 83.3% at 12 months and 36.3% at 24 months after replantation[10].

A new self-adhesive resin cement, CLEARFIL™ SA CEMENT, that has been developed recently by Kuraray, provides a reliable bond between a tooth and a metal or ceramic restoration material[11] .

MDP (10-methacryloxyydecyl dihydrogen phosphate ) created by Kuraray is an excellent adhesive phosphate resin monomer . The exceptional adhesive characteristics is due to its unique structure formula which is composed of polymerization group, dihydrogen phosphate group and long carbon (long alkylene) chain[12] .

Fiber-reinforced composites (FRCs) are multiphase materials with a unique combination of properties achieved with a specific proportion of each phase. Generally, enhanced mechanical characteristics of the material are achieved by incorporation of reinforcing fibers (discontinuous phase) into polymer matrix (continuous phase). Optimal reinforcement and transfer of stresses from matrix to fibers rely on an adequate interfacial bond between the two phases[13].

In the present study Ribbond THM (Ribbond; Seattle, WA, USA) was used which is plasma treated leno-woven, ultrahigh molecular weight polyethylene fibers. Ribbond fibres are woven using the lock-stitch leno weave which prevents slipping of fibres within resin matrix also prevents microcracks from propagating to form larger cracks and reinforces the restoration in multiple directions[14].

Interlig™ is a structure of interwined glassfibres pre-impregnated with light curable composite resin arranged in a braided design. Fracture resistance increases when fibres are placed close to the point where the force is exerted because it leads to a shorter working arm according to levers principle[15]. Consisting of glass fiber 60+/-5% impregnated resin 40+/-5%,bis GMA ,diurethane ,barium glass ,silicon dioxide ,catalyst .

Group I control group obturated with A H plus sealer gave the maximum fracture resistance because of its better adhesion properties to the root dentine, it forms a single unit within the root canals and bonds to the dentinal walls. The polymer-based sealer materials are resilient and along with GP form a perfect seal with the dentinal wall, and so it appears that both the materials have a good potential to strengthen the canal walls against fracture [16].

The FRC material contains a composite matrix impregnated with fibers. Reinforcement with fibres has shown to impart strength and toughness to composite resins. It derives its strength from the modulus and strength of its fibers, which are significantly higher than those of the matrix. Its strength is also dependent on the ability of the matrix to transfer stresses between the fibers hence group 3 and 4

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showed increase in the fracture resistance load compared to that of group 2 .

In this study group 3 polyethylene fiber showed increase in fracture resistance because of a lock-stitched leno-weave, the fibers maintain their orientation and width and when cut, do not unravel. They also do not shift within the composite or resin that they are reinforcing. A consistent fabric configuration provides for more reliable resin reinforcement, greater ease of clinical management during direct placement of composites ,and better composite resin crack-stopping capability [14].

In group 4 Glass fiber-reinforcing materials, did not give good result because they , are more rigid and cannot easily adapt closely to the teeth. When the fiber is not adapted closely to the teeth it leaves the composite material thicker on the tooth thus providing a decrease in durability of the reinforced composite in clinical function

## CONCLUSION

So to conclude, reinforcement with polyethylene fiber (ribbond THM) increases the fracture resistance under vertical forces when compared to glass fiber reinforcement (interlig ).

## RESULTS

**Table: 1 Summary statistics by four groups**

| Groups | N | Means | Std.Dev. | Std. Error |
|---|---|---|---|---|
| Group 1 | 15 | 409.67 | 46.92 | 12.11 |
| Group 2 | 15 | 252.00 | 60.02 | 15.50 |
| Group 3 | 15 | 343.33 | 72.71 | 18.77 |
| Group 4 | 15 | 262.27 | 40.38 | 10.43 |

**Table:2 Comparison of four groups with respect to vertical root fracture load in kgs (compressive load) by one way ANOVA**

| Source of variation | Degrees of freedom | Sum of squares | Mean sum of squares | F-value | P-value |
|---|---|---|---|---|---|
| Between groups | 3 | 247517.38 | 82505.7944 | 25.9432 | 0.00001* |
| Within groups | 56 | 178093.60 | 3180.2429 | | |
| Total | 59 | 425610.98 | | | |

***p<0.05**

**Table: 3 Pair wise comparison of of four groups with respect to vertical root fracture load in kgs (compressive load) by Tukeys multiple posthoc procedures**

| Groups | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|
| Means | 409.6667 | 252.0000 | 343.3333 | 262.2667 |
| Std.Dev. | 46.9158 | 60.0190 | 72.7095 | 40.3847 |
| Group 1 | - | | | |
| Group 2 | P=0.0002* | - | | |
| Group 3 | P=0.0112* | P=0.0004* | - | |
| Group 4 | P=0.0002* | P=0.9591 | P=0.0014* | - |

*p<0.05

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