The Effect of Resilon System on The Fracture Resistance Of Endodontically Treated Roots Using Two Instrumentation Techniques."An in vitro study"

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ABSTRACT

Background:-

Vertical Root Fracture (VRF) is one of the most common problems facing endodontically treated teeth. The greatest incidence of VRF occurs in teeth that have undergone endodontic therapy. The aim of this study was to evaluate the fracture resistance of endodontically treated roots using two instrumentation techniques either rotary with ProTaper system or hand instrumentation with k-files and obturated with different obturation techniques: Gutta-percha with ZOE. sealer, Gutta-percha with AH-26 sealer or Resilon cones with Real-Seal sealer.

Materials and Methodology:-

Ninety root samples were sectioned, from natural mandibular premolar teeth freshly extracted for various reasons and stored in sterile water, to a length of 14 mm, then the samples were randomly divided into 9 groups with ten roots for each group. **Group I**: Uninstrumented-unfilled roots, (control group) **Group II**: Hand instrumentation-GP+Z.O.E. sealer obturation. **Group III**: Hand instrumentation-GP+AH-26 sealer. **Group IV**: Hand instrumentation-Resilon+Real-Seal sealer. **Group V**: Hand instrumentation-No obturation. **Group VI**: Rotary instrumentation-GP+Z.O.E. sealer. **Group VII**: Rotary instrumentation-GP+AH-26 sealer. **Group VIII**: Rotary instrumentation-Resilon+Real-Seal sealer. **Group IX**: Rotary instrumentation-No obturation. The samples were incubated in 37 'c and 100% humidity for 7 days, and then they were subjected to the mechanical test in a universal testing machine and the maximum load at the fracture point for each sample was recorded.

Results:-

Descriptive statistics showed higher means of fracture loads for Resilon groups and student t-test showed a significant difference between Resilon group over other experimental groups for rotary instrumented roots, for hand instrumented roots there was no significant difference between different obturation techniques. Rotary ProTaper instrumented roots were significantly less than hand instrumented roots in resistance to fracture.

Conclusion:-

Rotary instrumentation with ProTaper instruments significantly decreased fracture resistance of teeth and Resilon system significantly increased resistance to fracture more than other obturation materials used in this study.

Key words:- Resilon, ProTaper, Fracture resistance, Vertical root fracture.

INTRODUCTION

Endodontically treated teeth are widely considered to be more susceptible to fracture than vital teeth. The greatest incidence of vertical root fracture occurs in teeth that have undergone endodontic therapy [1]. The prevelance of VRF among endodontically failed teeth is (10.9%) [2]. The most given etiology are; the dehydration of dentin after endodontic therapy, loss of tooth structure from caries, trauma and restorative and endodontic procedures, the removal of dentin during endodontic treatment and excessive pressure during obturation, retreatment or post space preparation [3]. Endodontic irrigants (NaOCl, EDTA) may affect the mechanical properties of dentine specimens after prolonged exposure. Many studies have reported a decrease in the micro hardness of dentine specimens treated with NaOCl only [4], EDTA only [5,6], or both [7]. Some studies have reported strong evidence that endodontically treated teeth, with or without posts, are susceptible to root fracture.

Conflicting reports have been published as whether the strength of roots (as measured

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by resistance to experimental root fracture) could be restored after canal preparation and root filling with a core material and sealer. Neither glass ionomer cement, zinc-oxide eugenol based sealer, nor epoxy resin-based sealer were able to strengthen endodontically treated roots significantly [8,9,10,11,12].

Recently, it has been reported that a new resin sealer (Resilon Pentron, Wallingfort, CT, USA) may possibly strengthen the root [13,14.15]. The Resilon system consists of a self-etching primer, urethane dimethacrylate (UDMA)-based sealer and polycaprolactone core material, which are claimed to create a 'monoblock' in which the sealer is bonded to both the canal wall and the core material. These Resin-based dental materials have been proposed as a mean to reinforce an endodontically treated tooth through the use of adhesive sealers in the root canal system. However, for a dental material to reinforce the tooth, the material must bond to dentin. Therefore, an essential attribute of a good dentin adhesive system is the adhesive's ability to wet and infiltrate dentin.

MATERIALS AND METHODS

Ninety single-canal freshly extracted mandibular premolars of comparable sizes were collected and stored in sterile water not more than one month, the age group of the patients from whom the teeth were extracted was limited between (16-26 years), the storage water was replaced daily to prevent putrefaction, teeth have been inspected under 10X magnification lens, and trans-illumenated with light curing unit and examined for the presence of any obvious cracks. The selected teeth were sectioned in the cemento-enamel junction using a diamond disk with water irrigation as a coolant to an equal length of the roots (14 mm) and the working length was determined. Ten mm of the roots were embedded in acrylic blocks surrounded by a 0.15 mm layer of poly-silicone impression material, then the samples were randomly divided into 9 groups 10 roots for each;

Group I: This group received no instrumentation technique and remained as a control group.

Group II: Received a hand instrumentation technique with 0.02 taper stainless steel k-files using step-back technique to size 40 MAF, irrigation and recapitulation after each enlarging size was done with 5 ml of 2.5 % NaOCl solution followed by 5 ml of distilled water and after instrumentation all the roots subjected to smear layer removal by applying 17% EDTA cream to canal wall with paper-points for 1 minute and washed by 10 ml of NaOCl solution followed by 10 ml of distilled water then the roots were dried with paper-points and filled with Gutta-percha 0.02 taper cones and Zinc-Oxide Euginol sealer using a lateral condensation technique with size 20 finger spreader and accessory cones.

Group III: Received the same irrigation and instrumentation technique as group II but the roots were filled with Gutta-percha and AH-26 sealer.

Group IV: Received a hand instrumentation technique and the roots were filled with Resilon cones and Real-Seal sealer.

Group V: Hand instrumentation with no obturation technique.

Group VI: Received a rotary instrumentation with ProTaper Universal rotary instruments on an (Endomate) micromotor to size F4 apical enlargement using the same irrigation materials and final irrigation as other groups and the roots were filled with ProTaper Gutta-percha and Zinc-Oxide Euginol sealer with a single cone technique.

Group VII: Received a rotary instrumentation technique and the roots were filled with ProTaper Gutta-percha and AH-26 sealer.

Group VIII: Received a rotary instrumentation technique and the roots were filled with Resilon cones and Real-Seal sealer.

Group IX: Rotary instrumentation with no obturation technique.

The samples were incubated in 37˚c and 100% humidity for 7 days. The coronal areas of the roots were prepared by using a diamond bur with a high speed turbine handpiece with water

coolant, the preparation was 2 mm in depth and 4 mm in diameter to accept the loading fixture which was a round ended stainless steel tube with 4 mm in diameter and 5 mm in length attached to an electric computer controlled universal testing machine.

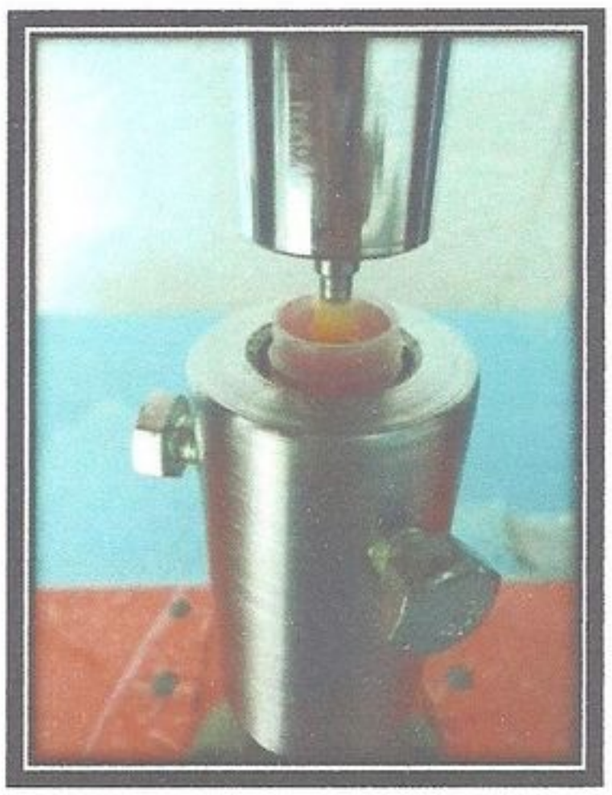

Figure (1): Sample mounted to the loading fixture.

The samples were subjected to mechanical test in a rate of 1 mm/minute a single load to fracture was used and the maximum load at the fracture point for each sample was recorded.

RESULTS

The means for fracture loads of the groups are listed in (Table 1) in newtons, higher means of fracture loads were seen in Resilon groups than the other obturation techniques, followed by the un-instrumented group, and then the other groups, the weakest group was the rotary instrumented un-filled group. Student t-test showed that un-instrumented roots were higher in fracture resistance with a significant difference(p-value=0.02) than hand instrumented roots and a highly significant difference (p-value=0.000) than rotary instrumented roots, and there was a significant difference (p-value=0.01) between hand instrumented roots and rotary instrumented roots with no obturation, Rotary instrumented-Resilon filled roots showed a statistically significant difference over the rotary instrumented-GP+Z.O.E. filled roots (p-value=0.003) and the rotary instrumented-GP+AH-26 filled roots (p-value=0.008); while for hand instrumented roots, "statistically" there was no significant difference between Resilon group and other obturation techniques.

Table (1): Descriptive statistics of the groups including the means, standard deviation (SD.), minimum (Min.) and maximum (Max.) values in Newtons and percentage of increase and decrease.

Groups	Brief description of the filling technique	Min.	Max.	Mean	SD.	Percent increase ↑ or decrease ↓ from control
Group I	Uninstrumented-unfilled roots	691	1101	888.6	138.931	---
Group II	Hand-GP+Z.O.E.	481	1081	848.2	192.037	↓ 4.5%
Group III	Hand-GP+AH-26	652	1087	864.6	155.921	↓ 2.7%
Group IV	Hand-Resilon+RS	735	1214	997.8	149.249	↑ 12.3%
Group V	Hand-No obturation	620	945	751.2	95.911	↓ 15.4%
Group VI	Rotary-GP+Z.O.E.	511	964	739	138.969	↓ 16.8%
Group VII	Rotary-GP+AH-26	579	1008	766.2	138.436	↓ 13.5%
Group VIII	Rotary-Resilon+RS	815	1090	928.3	100.246	↑ 15.8%
Group IX	Rotary-No obturation	459	846	613.6	118.911	↓ 31%

DISCUSSION

Root canal instrumentation is an unavoidable step in endodontic treatment. However, it is understood that as dentin is removed during the instrumentation phase, a weakening effect on the root is inevitable, in addition to the wedging forces of the spreader during lateral condensation, or excessive dentin removal to facilitate pluggers for vertical condensation; the potential for root fracture is very real. Many studies have suggested that as removal of tooth structure increases, fracture resistance of the tooth decreases [16,17]. Any material that can compensate for this weakening effect would be very useful. **Johnson et al. (2000)**[9] recommended the use of adhesive sealers in the root canal system to reinforce the root filled teeth.

The results of this study showed that rotary instrumented roots with F4 ProTaper instruments were less resistant to VRF than control uninstrumented roots with a highly significant difference and significantly less than hand instrumented roots with 0.02 taper ISO standardized k-files. This may be due to the increased taper and higher amount of tooth structure removed in rotary instrumentation with ProTaper instruments, that was similar to the findings of **Zandbiglari et al. 2006**[12] who concluded that studied roots were significantly weakened by the preparation with greater taper instruments and **Singla et al.** in **2010**[18] who found that canals instrumented with ProTaper F4 instruments showed maximum reduction in VRF resistance compared with other groups: (control uninstrumented group, hand instrumented .02 taper, Profile .04 taper and Profile .06 taper instrumented).

In the current study, all the obturated groups were significantly more resistant to fracture than the instrumented unfilled groups, so; it was concluded that all the filling materials used in this study appeared to strengthen the instrumented roots and restore teeth resistance to fracture. For rotary instrumented groups Resilon filled roots were significantly higher than Gutta-percha filled roots, these results agree with the findings of **(Teixeira et al. 2004; Hammad et al. 2007; Schafer et al. 2007)**[13,14,15]. This reinforcing effect of Resilon groups might be related to the capacity of Real-Seal sealer to bond resin based root canal filling material (Resilon) with dentin wall forming a 'monoblock' holding the tooth together and making it more resistance to fracture.

However, for hand instrumented groups, no significant difference was found between the roots filled with Resilon cones and Real-Seal sealer and other experimental groups, this agrees with the findings of **(Sagsen et al. 2006; Wilkinson et al. 2007; Ribeiro et al. 2008)**[19,20,21].

It is important to emphasize that these resin-based root canal filling materials are technique sensitive and it is difficult to compare the findings of this in-vitro study to clinical situation because the adhesion of Resilon system is affected by several factors; failure to completely remove the smear layer or sufficiently adapt the resinous sealer to root canal walls might interfere with its bonding in addition to the polymerization shrinkage of these resinous materials during setting, and it is also wise to consider the very high C-factor of root canals during polymerization of resinous endodontic sealers that may cause gaps along dentine/filling material interface. During photo-polymerization, the volume of monomer is significantly reduced, promoting enough shrinkage stresses to debond the material from dentine, thereby reducing adaptation and increasing microleakage [22,23]. All of that might interfere with the bonding of these materials to dentine walls minimizing its supporting effect. It is important to mention that Resilon obturation system does not have the same extensive evaluation that Gutta-percha and conventional sealers do. Further clinical implications of these promising adhesive materials are needed to search for an effective method to reduce the fracture susceptibility of endodontically filled teeth.

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