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Comparative Evaluation of Fracture Resistance of Roots Using Different Root Canal Filling Monoblock Systems: An Ex-Vivo Study

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Conflicts of Interest: Nil.

Introduction

The main aim of the root canal therapy is the treatment of the pulp space infection. However, endodontically treated teeth are widely considered to be more susceptible to fracture than vital teeth because of excessive loss of tooth tissue, widening of root canals , dehydration of dentine after endodontic therapy or application of excessive pressure during filling procedure.[1] The most frustrating complication to root canal therapy is vertical root fracture that extends throughout the entire thickness of dentin from the root canal to the periodontium.[2] These fractures present a challenge to the clinician and the diagnosis is often difficult and based on subjective parameter.[3] Gutta-percha has long filled most of the “Gold Standard” prerequisite, of ideal root canal filling material.[4] The adhesive strength is however weak and a fluid tight seal cannot be achieved due to a chemical union between the poly-isoprene component of gutta-percha and methacrylate based resin sealers.[5] However, adhesive dental obturating are now available that may offer an opportunity to reinforce the filled tooth through the use of bonded sealers in the root canal system.[1]

The term monoblock has become familiar in the endodontic literature with recent interest in the application of dentin adhesive technology. Tay & Pashley (2007) indicated that replacement monoblock created in the root canal spaces may be classified as primary, secondary or tertiary depending on the number of interfaces present between the bonding substrate and the bulk material core.[6] In 2004, a new obturation system was introduced under the name RealSeal (Pentron Clinical Technologies, Wallingford, CT) containing Resilon cones and Epiphany sealer. Resilon is a thermoplastic synthetic resin material that is based on polymers of polyester and contains bifunctional methacrylate resin, bioactive glass and radiopaque fillers.[1,6,7] A new obturating material

commercially known as ActiV GP (Brasseler, Savannah GA) is marketed as a monoblock system by using conventional Guttapercha cones that are surface coated with glass-ionomer fillers using a proprietory technique.[1,6,8] Several studies reports the sealing properties, bacterial leakage and push-out bond strengths of this material.[8,9] However, studies on the fracture resistance or the strengthening potential of roots filled with ActiV GP needs to be explored further.

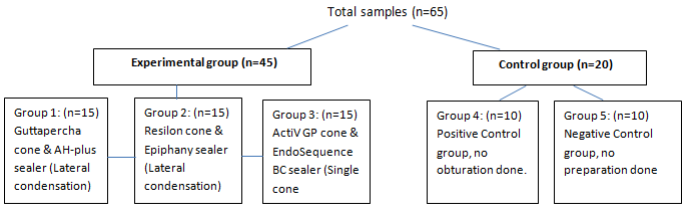
Hence, this ex vivo study was conducted to assess fracture resistance of single rooted teeth filled using the RealSeal adhesive system and ActiV GP single-cone technique and to compare these results with those obtained using the conventional gutta-percha cone and AH-plus sealer with cold lateral compaction technique.

Materials And Methods

The study was conducted in Department of Conservative Dentistry and Endodontics, Subharti Dental College, Meerut, in collaboration with the Apex Assessment Labs Pvt. Ltd, Anand Industrial Estate, Mohan-nagar, Ghaziabad. A total of Sixty five recently extracted intact and caries-free human mandibular premolar teeth with single straight root canals and mature apices were used in the study. Extraneous soft tissue, superficial debris and calculus were removed from the roots with an ultrasonic scaler and the teeth were disinfected with 5.25% sodium hypochlorite solution. The selected teeth were then examined under an operating microscope to evaluate for micro cracks. All unacceptable teeth were discarded and the selected teeth were stored in deionized water under 4 °C until use. To standardize the procedure, the specimens were prepared as follows:

- To standardize the length of the canal, the teeth were decoronated at cemento-enamel junction or below cementojunction using water-cooled diamond disc along with the straight handpiece and micro-motor, to get approximately 12 mm length of samples.
- The working length was established in fifty specimens by deducting 1mm from the actual canal length, which had been determined by inserting number 15 K-file into the canal until the tip of the file was just visible at the apical foramen.
- The coronal half of each canal was preflared using Gates Glidden drills sizes 1 & 2, corresponding 90 and 110 ISO sizes. Biomechanical preparation was done using rotary Endo-Sequence files of .06 taper along with 16:1 gear reduction handpiece using crown down technique till 35 number, master apical file. During cleaning and shaping passive irrigation was performed using 30 gauge, side-vent needle with 2 ml of 3% sodium hypochlorite after each instrumentation. Following this procedure, the dentinal smear layer was removed from the canal walls by using 2ml of 17% EDTA solution for 3 min. The canals were then washed finally with double distilled water and dried with sterile absorbent points.

Sample size distribution:



Assessment of the obturation: Each specimen was radiographically evaluated in bucco-lingual and mesio-distal direction for the obturation. Criteria for the assessment of good obturation was that the filling was well adapted to the canal walls and that showed only few minor areas of radiolucency. All the sixty-five samples were stored in the incubator at 37°C with 100% humidity for 14 days.

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Testing of samples: The specimens were mounted with the vertically aligned roots on the lower plate of the universal testing machine and a compressive loading was applied vertically to the coronal surfaces of roots with a loading rate of 1 mm min-1 until fracture occurred. The load at which failure occurred was recorded and expressed in Newtons (N).

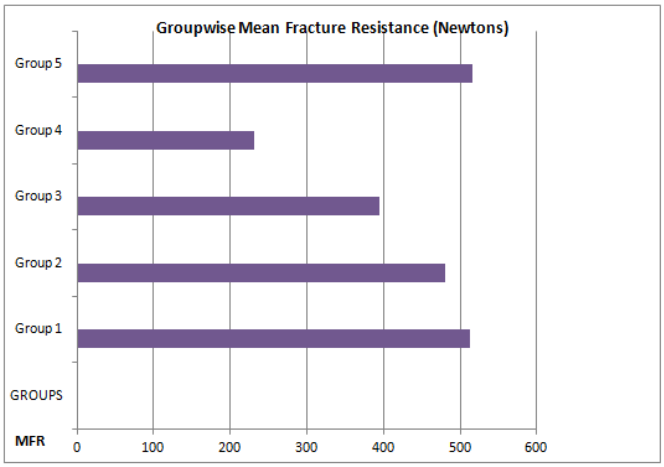
Statistical Analysis

For statistical analysis one way ANOVA-F test was used for comparison of groups. An unpaired student t-test was used for the multiple comparisons.

Results

GROUPS (N)	MEAN±SD	STANDARD ERROR
Group 1 (N=15)	513.181 ± 20.07	5.182
Group 2 (N=15)	480.224 ± 24.62	6.356
Group 3 (N=15)	395.366 ± 18.88	4.874
Group 4 (N=10)	230.555 ± 36.09	11.412
Group 5 (N=10)	516.58 ± 8.62	2.314

TABLE 1: Mean fracture values (in Newton) obtained for various groups.



On comparing Mean and Standard deviation values it was seen that samples of Group 5 showed highest fracture resistance followed by Group 1, Group2, Group 3 and Group 4 showed the least fracture resistance.

PAIR OF GROUPS	P- VALUE	INFERENCE
Group 1 & Group 2	P<.05	Significant
Group 1 & Group 3	P<.05	Significant
Group 2 & Group 3	P<.05	Significant
Group 1 & Group 4	P<.05	Significant
Group 2 & Group 4	P<.05	Significant
Group 3 & Group 4	P<.05	Significant
Group 4 & Group 5	P<.05	Significant
Group 1 & Group 5	P>.05	Not Significant
Group 2 & Group 5	P<.05	Significant
Group 3 & Group 5	P<.05	Significant

TABLE 2: Between group comparisons.

Group 5 (Negative control group) had the highest scores of the mean fracture when compared with other experimental groups (Groups 1, 2 & 3), the results were statistically significant (P<0.05). Group 4 (Positive control group showed fracture at very less loads in comparison to Group 5 and the results were statistically significant (P<0.05). The Fracture of Group 5 (mean fracture load in Newtons 516.58 ± 8.62) were comparable to Group 1 (mean fracture load in Newtons 513.181 ± 20.07). This result implies that teeth filled using AH-Plus resin in combination with Gutta-percha have least difference than an unprepared tooth in term of fracture resistance. When Group 1 was compared with Group 2 and Group 3, it showed higher mean fracture load which was statistically significant (P<.05).

DISCUSSION:

Root filled teeth may be more susceptible to fracture because of excessive loss of tissue, dehydration of dentine and excessive pressure during filling procedures.[1] Endodontically treated teeth have certain unique aspects which differ from the teeth with viable pulp.[10] These aspects make the root filled teeth more brittle than teeth with pulps and there is a general trend to restore them with a reinforcing material.[11] however, Sedgley and Messer (1992), stated that other factors may be more critical to failure and concluded that its rather the cumulative loss of the tooth structure from caries, and restorative and endodontic procedures that led to to fracture.[12] Reeh et al (1989) reported that the amount of tooth structure lost, in particular loss of marginal ridge integrity, play a more

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important role in reduced fracture resistance.[13] In the present study, sixty five recently extracted intact and caries-free human mandibular premolar teeth were selected for root canal treatment using five different materials. The samples in the experimental groups were obturated using AH- plus sealer and Gutta-percha (Group 1), Epiphany sealer and Resilon cone (Group2) and EndoSequence BC sealer and ActiV GP cone(Group 3).

The creation of a 'mono-block' of material that adheres to the canal wall strengthening the endodontically treated teeth is appealing. However, a 'mono-block' of gutta-percha in the root has not been possible, due to lack of chemical union between percha (a polyisoprene) and various sealers, such as zinc oxideeugenol, epoxy resin, and glass ionomer– based sealers.[14] When compared to Gutta-percha, Resilon allows the bonding agent to attach to the resin core and the dentin wall, thus forming a monoblock. The reinforcement of the root canal dentine is dependent on the production of adhesive system inside root canal, thus increasing fracture resistance.[1,15,16] However, Williams et al (2006), in his study found that, Resilon as compared to Gutta is not stiff enough to provide a mechanically homogenous unit root dentine.[17] Another obturating system which has been used in this study is ActiV GP, produced apical seal to fluid filtration that are comparable to that of gutta-percha and AH Plus sealer. However, limited information is available especially on fracture resistance of teeth obturated with this system.[1,15,18]

Hanada T, Quevedo CG et al. (2010) compared the fracture resistance of roots following root therapy using the RC Sealer system, the Epiphany system and the conventional system of gutta-percha and Seal apex. There was no significant improvement in resistance to vertical root fractures compared with conventional gutta-percha and sealer.[19] In contrast, in certain studies Resilon showed stronger adhesion to the dentinal walls compared with gutta-percha.[20] Teixeira et al. (2004) showed that Resilon groups displayed significantly higher mean fracture load values than those of gutta-percha groups.[21] Rajesh R Shetty et al. (2009) compared the fracture resistance of endodontically treated roots filled with Resilon and Gutta-percha and concluded that the filling of the root canals with Resilon increased in vitro fracture resistance of endodontically treated roots to standard gutta-percha techniques.[22] The result of the present study indicates that fracture resistance of Group 3 is not superior to the other systems in terms of root reinforcement and fracture resistance. The fracture resistance of Group 5 was significantly higher than Group 4. Significant difference was among the three experimental groups (Group 1, Group 2 and 3) in which Group 1 showed highest fracture resistance and Group 2 and Group 3 showed lower fracture resistance. Obturation with Gutta-percha and AH-plus sealer gives a significantly high fracture resistance as compared to Resilon with Epiphany sealer and ActiV GP with EndoSequence Bioceramic sealer.

Limitations

Under the limitations of this study, it has been found that obturation with Gutta-percha and AH-plus sealer gives a significantly high fracture resistance as compared to Resilon with Epiphany sealer and ActiV GP with EndoSequence BC sealer. However, large sample size along with clinical trials is necessary to validate the results of the present ex-vivo study.

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