Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr UGC approved journal no. 63854

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Article

Comparative Evaluation Of Root Filled Teeth With Monoblock Obturation Systems: An Ex-Vivo Study

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ABSTRACT:

Aim – The aim and objective of the ex vivo study is, to assess fracture resistance of single rooted teeth filled using the Real Seal 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 using cold lateral compaction technique. **Methodology** – Sixty freshly extracted human mandibular premolar teeth with similar dimensions were selected, which was decoronated at the cemento-enamel junction, and length of the roots was adjusted to 12 mm. The specimens were randomly divided into five groups. The biomechanical preparation was done using Brasseler Endo Sequence rotary file system upto the file # 35 and copious irrigation was done using 2 ml of 5.25% NaOCl followed by 2 ml of EDTA and final irrigation done using distilled water, following each instrumentation . The teeth in each group were obturated as follows: Group 1; AH-plus sealer and gutta-percha cone (Cold lateral compaction), Group 2; Epiphany sealer and Resilon cone (Cold lateral compaction), Group 3; ActiV GP cone and Endo Sequence BC sealer (Single cone), Group 4; Positive control group, Group 5; Negative control group. After the sealers had set, the specimen were embedded in acrylic moulds and subjected to a compressive loading in the universal testing machine. **Results** – The load at which complete fracture occurred was recorded and statistically analysis done using ANOVA one-way analysis of variance and unpaired t-test. The statistical analysis concluded that the fracture resistance Group 5 showed highest fracture resistance followed by Group 1, Group2, Group 3 and Group 4 showed the least fracture resistance. Fracture resistance in decreasing order: Group 5 > Group 1 > Group 2 > Group 3 > Group 4

Conclusion : 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 Endo Sequence BC sealer.

Key words: Bioceramic sealer , Monoblock , Resilon, Sodium Hypochlorite.

Received: 4 February, 2019 Revised: 25 February, 2019 Accepted: 26 February, 2019

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This article may be cited as: Bhandari M, Nikhil V, Grover S, Jaiswal S, Srivastava N. Comparative Evaluation Of Root Filled Teeth With Monoblock Obturation Systems: An Ex-Vivo Study. J Adv Med Dent Scie Res 2019;7(3): 87-91.

INTRODUCTION

Endodontically treated teeth are widely considered to be more susceptible to fracture than vital teeth. Their strength is related directly to the method of canal preparation and to the amount of remaining sound tooth structure.[(1,2)] The most frustrating complication to root canal therapy is vertical root fracture, a longitudinal fracture of the root, extending throughout the entire thickness of dentin from the root canal to the periodontium.[(3)] According to Bender and Freedland, the greatest incidence of vertical root fracture occurs in teeth that have undergone endodontic therapy often leading to extraction.[(4)] These fractures are challenging for the clinician in terms of diagnosis. In an attempt to reduce such complications, the concept of reinforcing the root canal system was introduced which is based on the production of adhesive system inside root canal by use of adhesive obturating materials and bonded sealers.[(2,5)] The term "Monoblock" in Endodontics literally means a

single unit and it has been employed in dentistry since the turn of the century. [6]

Tay & Pashley 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] Secondary monoblock is classically perceived in Restorative and Endodontic literature. In 2004 RealSeal (Pentron Clinical Technologies, Wallingford, CT) containing Resilon cones and Epiphany sealer was used in combination with self etching pr imer to create a solid monoblock. Resilon is a thermoplastic synthetic resin mater ial that is based on polymersof polyester and contains bifunctional methacrylate resin, bioactive glass and radiopaque fillers. [1,2,6,7]

In 2007, ActiV GP (Brasseler, Savannah GA), a root filling system marketed as tertiary monoblock system using conventional Gutta-percha cones surface coated with glass-ionomer fillers using a propr ietory technique was introduced which transformed it into a gutta-percha core /cone, enabling the latter to be functional both as the tapered filling cone and as its own carrier core, thus avoiding the need for a separate interior carrier. The glass-ionomer filler -coated gutta-percha cone also allowed it to be bonded to root dentine via bioceramic glass-ionomer sealer,creating a claimed, 'Single-cone monoblock obturation'.[1,6,8] Tay & Pashley in a review of monoblock systems in endodontics, indicated that there is limited infor mation regarding this technique and need further exploration. [6]

The purpose of this laboratory study was to assess the fracture resistance of endodontically treated single rooted teeth when obturated using different materials the RealSeal adhesive system with lateral condensation technique / ActiV GP using its proprietory cone as a single-cone technique / gutta-percha and AH-plus sealer using cold lateral compaction technique.

MATERIAL & METHOD

Sixty five recently extracted intact caries-free human mandibular premolar teeth with single straight root canals and mature apices were selected, cleaned with an ultrasonic scaler and disinfected with 5.25% sodium hypochlorite solution. They were stored in deionized water under 4 °C. Specimens were prepared by decoronating teeth at or below CEJ using water -cooled diamond disc to get standard length of 12 mm. 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. Then 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 hand piece using crown down technique till 35, master apical file. Passive irrigation was performed using 30 gauge, side-vent needle with 2 ml of 3% sodium hypochlorite after each instrumentation and 2ml of 17% EDTA solution was used for 3 min. The canals were finally washed with distilled water and dried with sterile absorbent points. Then specimens were randomly divided into five groups based on obturating material.

Group 1: Gutta-percha with AH-Plus sealer (n = 15)
Gutta-percha master point of size 35, 6% taper was selected, inserted to the full working length and checked for its snug-fit, coated with sealer and placed . Obturation was completed with lateral compaction technique. GP was condensed 3mm vertically and coronally sealed with CAVIT

Group 2: Resilon cones with Epiphany sealer (n=15)
The size 35, 6% taper Resilon cone was placed to the appropriate working length and checked for the Tug-back. Epiphany was placed as per manufacturer's instructions. The selected master cone and medium- fine Resilon accessory cones dipped in resin sealer were used in lateral compaction technique . Subsequently, the tip of curing light was placed close to the coronal area to light cure the sealer for 40 seconds. The coronal material was condensed vertically, 3 mm of coronal seal was provided.

Group 3: ActiV GP cone with EndoSequence BC sealer (Precision Obturation System) (n=15)
A size 35 & 6% ActiV GP cone coated with ActiV GP sealer and checked for the Tug-back. Excess material was seared off and condensed with a hot number 4 finger plugger. Following root filling, 3 mm of coronal seal was provided.

Group 4: Positive control group (n=10)
Preparation was done using Rotary Endo- Squence file and 3 mm of the coronal seal was achieved by CAVIT .

Group 5: Negative control group (n=10) intact teeth.

Specimens were 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 that showed few minor areas of radiolucency. Samples were incubated at 37°C in 100% humidity. After 14 days samples were prepared for the test by making acrylic resin cylinders 20 mm in diameter and 20 mm high using cylindrical moulds the roots were embedded in them. The temporary filling material was removed so that root canal could accept the loading fixture.

Testing of samples

The specimens were mounted with the vertically aligned roots on the lower plate of the universal testing machine and compressive loading at the rate of 1 mm min^{-} was applied vertically to the coronal surfaces of roots until fracture occurred, value was recorded and expressed in Newtons (N). Statistical analysis was done using one way ANOVA- F test and unpaired student t- test.

RESULT

On comparing the mean and standard deviation values as shown in Table 1, Group5 (516.58 ± 8.62) showed highest fracture resistance followed by Group 1 (513.181 ± 20.07), Group 2 (480.224 ± 24.62), Group 3 (395.366 ± 18.88) and Group 4 (230.555 ± 36.09) showed the least fracture resistance.

The statistical analysis concluded, fracture resistance of obturated teeth was significantly higher than non obturated teeth. Significant difference was observed among the three experimental groups in which AH-plus sealer and gutta-percha showed highest fracture resistance followed by Resilon and Epiphany group. The EndoSequence Bioceramic sealer and ActiV GP cone showed least fracture resistance. The fracture resistance shown by AH-plus & gutta-percha group was comparable with intact teeth group. The ActiV GP and Resilon showed significantly lower fracture resistance than intact teeth.

Table 1:

Mean fracture values obtained for the experimental groups

On comparing Mean and Standard deviation values as shown in Table 1 (Group 1: 513.181± 20.07, Group 2: 480.224 ± 24.62, Group 3: 395.366 ± 18.88, Group 4: 230.555 ± 36.09 and Group 5: 516.58 ± 8.62), 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.

Groups	Mean ± Standard deviation	n (total sample size	Standard error mean
Group 1	513.181 ± 20.07	15	5.182
Group 2	480.224 ± 24.62	15	6.356
Group 3	395.366 ± 18.88	15	4.874
Group 4	230.555 ± 36.09	10	11.412
Group 5	516.58 ± 8.62	10	2.314

DISCUSSION

Endodontically treated teeth have certain unique aspects which differ from teeth with viable pulp include: loss of moisture , alterations in nature and collagen alignment strength and altered biomechanics in pulpless teeth.[9] All 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.[10] However, there are some conflicting reports with this possibility. Reeh et al reported that the amount of tooth structure lost, in particular the loss of marginal ridge integrity, seemed to play an important role in reduction of fracture resistance.[11] Studies shows that biomechanical preparation weakens the tooth structure, while canal filling and adhesive material further increases the fracture resistance.[1]

Preparation was done using EndoSequence (Real World Endo Brasseler USA) rotary file system. These have alternate contact points which prevents screwing of the file into the canal, maximizes cutting efficiency. They have non-active tip and are fully active precisely at 1 mm.[20,21] Versluis et al indicated that canal preparation when done with Endo Sequence file; results in rounder cross section which may positively affect force distribution inside canal hence decreases the stress generated during obturation.[14]

Endodontic instrumentation produces smear layer which has a potential to delay penetration of antimicrobial agents.[15] The irrigation protocol was standardized with use of 2 ml 5.25% NaOCl followed by 2 ml of EDTA after each instrumentation. However, Sodium hypochlorite also breaks down to sodium chloride and oxygen, may cause strong inhibition of interfacial polymerization and interfere with resin infiltration into the tubules.[15,16] Hence, distilled water used for final irrigation to neutralize this effect.

The experimental group samples 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 test was terminated at "fracture" where complete instantaneous drop of the applied load was observed in the universal testing machine under compressive loading. The sample had only 4 mm of root dentin exposed above embedding material. This resulted in smaller stresses due to decreased bending movements and maximum stress located more cervically. This design is more relevant clinically as it efficiently simulates the support given to healthy teeth by alveolar bone and resulted in less catastrophic stress builds up caused by unrealistic bending movements.[1,16]

Group 5 samples had highest scores of the mean fracture resistance (516.58 ± 8.62 N), when compared with other experimental groups (Groups 1, 2 & 3), results were statistically significant ($P<0.05$). The reason may be that root canal preparation weakens the roots and obturation improves the fracture resistance of instrumented teeth, strength obtained is not comparable to that of intact teeth. Group 4 showed fracture at very less load (230.555 ± 36.09 N) in comparison to Group 5 and results were statistically significant ($P<0.05$). This may be attributed to two reasons : root canal instrumentation reduces the amount of remaining dentin thickness significantly affects fracture resistance. Also, mechanical instrumentation produces craze lines on root canal wall, which may serve as localized sites of increased stress. Group 4 (230.555 ± 36.09 N) showed significantly lower mean fracture values which indicated that obturation reinforces root weakened by biomechanical preparation.

The Fracture of Group 5 (516.58 ± 8.62 N) were comparable to Group 1 (513.181 ± 20.07 N). This result implies that teeth filled using AH-Plus resin in combination with Gutta-percha have least difference than unprepared tooth in term of fracture resistance. This may be attributed to the fact that AH Plus sealer has better penetration in the micro irregularities, which increases mechanical interlocking between sealer and root dentin. This fact, allied to the cohesion among sealer molecules, increases the resistance to removal and /o r displacement from dentin. [17]

When Group 1 (513.181 ± 20.07 N) was compared with Group 2 (480.224 ± 24.62 N) and Group 3 (395.366 ± 18.88 N), result was statistically significant (P<.05). The explanation can be that the cohesive strengths and moduli of elasticity values for Resilon are too low to reinforce roots of endodontically treated teeth. Recently, some critrisim has been brought regarding Resilon adhesive and reinforcing proper ties.[1]

The modulus of elasticity of Resilon was found to be 86.6 ± 43.2 MPa, under dry conditions and 129.2 ± 54.7 MPa after 1 month of water sorption. Considering that the modulus of elasticity of root dentine is 16,000 – 18,000 MPa and the fact that the similarity of the elastic moduli of the components plays a major role in the creation of successful monoblock system, it is still questionable whether Resilon obturation system actually creates monoblock effect in the root canal.[1,2,6] When compared to Gutta-percha, Resilon allows 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. However, Williams et al found that, Resilon is not stiff enough to provide mechanically homogenous unit inside root dentine.[7] Hanada T et al compared the fracture resistance of obturated roots using RC Sealer , Epiphany and conventional system of gutta-percha and Sealapex. There was no significant improvement in resistance to vertical root fractures. [18]

In contrast, Olgaonay et al found that the use of Resilon showed stronger adhesion to the dentinal walls when compared with gutta-percha.[19] Teixeira et al. showed that Resilon displayed significantly higher mean fracture load values than those of gutta-percha when subjected to vertical loading forces.[2] Shetty et al concluded that the filling of the root canals with Resilon increased fracture resistance of endodontically treated roots to standard gutta-percha techniques.[20] Few studies have shown that regardless of obturation technique, single canal teeth with Resilon demonstrate higher fracture load than with gutta-percha. By contrast, similar values for fracture have been reported for single rooted teeth obturated with either material using cold lateral compaction technique. There are two schools of thoughts and different studies conducted backing up both the opinion, which need further conclusive results.

Group 3 (395.366 ± 18.88N) has lower mean fracture load as compared to Group 1 (513.181 ± 20.07N) and Group 2 (480.224 ± 24.62N). The result indicates that fracture resistance of Group 3 is not superior to the other systems in terms of root reinforcement and fracture resistance. While using ActiV GP obturation system, single cone had been used where as in other two groups, lateral compaction technique was used. The reason of the lower fracture resistance of this group is the core material would be less and volume of sealer would be more as compared to other groups. ActiV GP sealer is glass ionomer based sealer which undergoes shrinkage like other self-curing glass-ionomer cements and resin composites. The increased volume of sealer could lead to increased shrinkage during its setting phase, creating gaps between the sealer and root dentine, which further decreases fracture resistance. [21]

This issue may be the consequence of unfavorable cavity geometry encountered in root canals. The presence of irregular-shaped canals do not allow optimal filling with a single-cone approach and would be the possible reason for lower fracture mean value. [6] The inclusion of surface coating of glass ionomer fillers on ActiV GP gutta-percha cones purportedly allows them to be bonded to glass-ionomer sealer, thereby improving seal between root filling material and sealer. Conceptually, this would create a monoblock between the root filling material and dentine within root canal. However, according to the study by Monticelli et al., SEM examination of these cone surfaces revealed that the filler density is non-homogenous. The filler-sparse regions may represent areas where the fillers have been dislodged from the cone.[8]

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 Endo Sequence 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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Source of support: Nil **Conflict of interest:** None declared

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