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Comparison of sealing ability of three root canal sealers – iRoot SP, AH Plus and Vitapex- An invitro study

Abstract:

Objective: The aim of this study is to investigate the apical sealing ability of a newly introduced root canal sealer: iRootSP Root Canal Sealer. Study design. One hundred extracted human anterior single-root teeth are used. The coronal part of each tooth were removed and the root canals were prepared with ProTaper les. The specimens are divided into 3 groups of 30 teeth each. Group I specimens are obturated with iRoot SP sealer by lateral condensation of guttapercha; Group II specimens are obturated with AH plus using lateral condensation technique; Group III specimens are obturatedwith Vitapex by lateral condensation of guttapercha. Evaluation of the apical leakage is performed by dye penetration method.

Results: The results showed significant difference between sealers. Vitapex sealer showed significantly more leakage when compared to iRoot Sp and AH Plus. iRootSp and AH Plus showed statistically significant difference in micro leakage and the better result was shown by iRoot SP.

Conclusion: iRoot SP showed less leakage than AH Plus sealer and Vitapex showed maximum dye penetration among the three groups .

Key-words: iRoot SP, AH plus, Vitapex, microleakage, Dye extraction method

Introduction:

In endodontic therapy, cleaning and shaping of the root canal system is complemented with a three-dimensional fluid-tight filling with a chemically inert, biologically compatible, and dimensionally stable material. Root canal filling materials are classified as core materials and sealer cements. Regardless of the core material, a sealer is essential to every obturation technique employed and helps achieve a fluid-tight seal of the root canal system. A root canal sealer fills the gaps between gutta-percha points and the walls of the root canal. It also fills the voids between individual gutta-percha points applied during obturation of the root canal system.[1]

Unless, a dense, well adapted root canal filling is achieved, the prognosis may be compromised regardless of how other phases of the treatment are carried out.[2]

An ideal root canal sealer should be biocompatible, antibacterial, nontoxic, and radiopaque, and itshould also hermetically seal the root canal system, be dimensionally stable, and should have good adhesion to the root canal wall.[3] A new obturation sealer, iRoot SP root canal sealer (Innovative BioCreamixInc, Vancouver, Canada), has recently been introduced to the market. According to the manufacturer's description, iRoot SP is a convenient, premixed, ready-to-use injectable white hydraulic cement paste developed for permanent root canal filling and sealing applications. iRoot SP is an insoluble, radiopaque, and

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aluminium-free material based on a calcium silicate composition, which requires the presence of water to set and harden. To date there appear to be few studies evaluating the apical sealing of this new material. The purpose of the study was to evaluate the sealing ability of iRoot SP using dye penetration technique.

Materials and Methods:

Preparation of teeth

One hundred extracted human anterior single-root teeth were selected for study. Roots with open apices, cracks, and resorptive defects were excluded. Teeth were cleaned of extraneous tissue and calculus and then rinsed and stored in saline solution before instrumentation. De-coronation of the teeth up to the cemento-enamel junction with an abrasive diamond disc was done to permit ideal access to the root canal.

A size 10 K-file was then inserted into the canal until it was just visible at the apical foramen. Working length was determined by subtracting 1 mm from this length. The canals were instrumented using a crown-down technique with rotary ProTaper nickel-titanium files (Dentsply Maillefer) to F3. All canals were irrigated with 10 mL of a freshly prepared solution of 5.25% sodium hypochlorite (NaOCl) between files. After completion, the smear layer was removed by a wash in 10 mL of 17% EDTA for 60 seconds, followed by a wash of 5.25% NaOCl. 5The canal was then dried with sterile paper points.[4]

Obturation of canals:

The specimens were randomly divided into 3 groups of 30 samples each. Five teeth were set aside as negative control and another five were designated as positive control.

Group I: iRoot SP (Innovative Bio CreamixInc, Vancouver, canada). Specimens were obturated by lateral condensation technique using iRoot SP.

The master cone size 30 was selected to fit the canal snugly. The sealer was inserted in to the root canal using the 'Canal Tip' provided by the manufacturer. The gutta-perchamastercone was also coated with the sealer and slowly inserted into the canal. Accessory cones were placed with a coating of sealer and coronal surplus of gutta-percha was removed with a heated instrument and the gutta.

Group II. AH-Plus (De Trey/Dentsply, Konstanz, Germany). The master cone size 30 was selected to fit the canal snugly. AH Plus sealer was mixed according to the manufacturer's instructions. The canals were coated with sealer using master cone. Selected master cone was coated with sealer and placed in canal and accessory cones were condensed laterally using the same method as in group I. The coronal surplus ofgutta-perchawas removed with a heated instrument and the gutta-perchacompacted.

Group III. Vitapex (Neo dental international inc. 2505 South 20th street, Suite 625 Federal Way, WA 98003). Master cone size 30 was selected tofit the canal snugly .The canals were coated with vitapexsea lerusing master cone. Master gutta-perchacone was coated with sealer and seated and accessory cones were condensed laterally using the same technique as in group I. The coronal surplus of gutta-percha was removed with a heated instrument and gutta-percha compacted.

Positive and negative controls:

Five root segments that were filled with laterally condensed gutta-perchaconein the absence of a sealer and not coated with nail varnish were used as positive controls to test the maximum dye penetration through the root canals.

Five root segments were filled with gutta-percha alone without sealer by lateral condensation were used as negative controls. External surface of these teeth were fully coated with nail varnish**.**

Following obturation of each group, gutta-percha was removed from the corona l2 mm of the obturated root canals with awarm instrument and the coronal end of all canals were sealed with Glass ionomer cement.

Measurement of microleakage:

The specimens were placed in cotton moistened with sterile water to attain 100% humidity and kept at 37°C for seventy two hours to ensure complete setting of the sealers. The roots of all experimental groups were coated with two layers of nail varnish except for approximately 2 -3 mm of tooth structure beyond the apical opening. Teeth in the negative control group had the entire root surface coated with nail varnish and positive control groups were uncoated with varnish.

After the varnish was completely dry, each tooth was placed in a petri-dish with apex immersed in 5% Methylene blue dye with PH 7. The roots were dipped in the dye for 7days. Following this, they were removed from the dye solution and rinsed under running tap water. Nail varnish from the surface

of root is scraped off. The specimens were kept in a polythene bag and kept in freezer for 8 hours before sectioning. Specimens were tightly covered in a polythene bag to prevent water condensation on specimens .The roots of each tooth is grooved longitudinally on both sides using a rotating diamond disc under constant cooling with distilled water without disturbing the guttapercha filling. The root is then carefully sectioned. Each section is then viewed under a stereo microscope. Linear dye penetration was measured in bisected specimens by a calibrated scale using a stereo microscope micrometer.(Fig 1,2,3). The distance from the end of the root filling to the end of the dye penetration was measured in millimeters followed by statistical analysis of all the groups.

Statistical analysis:

The measures of central dispersion including the mean and standard deviation of linear micro leakage (dye penetration depth) in the root canals in different groups were calculated. Since the linear microleakage data were normally distributed, one way analysis of variance (ANOVA).was applied to compare the micro leakage among the groups.

Multiple comparisons of microleakage values were performed using Bonferroni test.The level of significance was set at 0.05.

Results:

The mean amount of microleakage (dye penetration depth) was 0.7777 ± 0.55443 µm in i Root, 1.4997 ± 0.90061 µm in AH Plus, 2.2793 ± 0.78332 µm in Vitapex , and 13.78 ± 1.59437 µm in the positive control group [Table 1 and 2]. One-way ANOVA showed a significant difference among the four groups in the amount of linear microleakage ($P < 0.001$). The maximum value was noted in the positive control and the minimum value was noted in the i Root .The leakage of the negative control, measured by stereomicroscope was uniformly 0, and the leakage of the positive controls was immeasurably high. A one way ANOVA test showed there is significant difference among the experimental groups ($P < 0.001$)

Discussion :

A wide variety of root-canal sealers are available commercially. iRoot SP Root Canal Sealer, an aluminium-free sealer based on a calcium silicate composition, was recently introduced to the market. According to the manufacturer, iRoot SP is composed of biocompatible and nontoxic materials that include calcium phosphate, calcium silicates, zirconium oxide, and calcium hydroxide. iRoot SP includes a similar composition to white mineral trioxide aggregate (MTA) material and has both excellent physical properties and biocompatibility. iRoot SP can form a hermetic seal inside the root canal and be used for filling root canals with or without gutta-percha points. Superior quality sand handling abilities make iRoot SP an innovative novel root canal sealer. To date only scant knowledge is available with regard to its sealing ability.

The current study focused on the ability of materials to seal the apex because relative to the coronal part, apical sealing remains relatively vulnerable to microbial leakage. Furthermore, apical leakage jeopardizes the biological response to endodontic sealers because it facilitates the release of unreacted components from materials directly into the periapical tissues.[5] Apical seal continues to be a topic of interest because of occurrence of clinical failures in spite of the advances in endodontics.[6]

In the present study, apical sealing ability of a newly introduced sealer i Root SP was compared with AH plus (resin based sealer) and vitapex (calcium hydroxide and iodoform based sealer).In this study cold lateral condensation was done .The cold lateral condensation (CLC) of gutta-percha is one of the most widely used techniques and often has been used as the standard to which the sealing ability of new filling techniques or materials are compared.[7]

It is well known that root filling materials penetrate better into dentinal tubules in the absence of smear layer. The removal of smear layer as well as soft tissue and debris can be achieved by the alternate use of EDTA and NaOCl.[8] or this reason, root canal was flushed with 10 mL of 17% EDTA for 60 seconds, followed by a wash of 5.25% NaOCl to remove the smear layer and to allow the penetration and adaptation of root canal filling materials in the present study.

In our study, dye penetration technique with methylene blue was used to compare the apical leakage. Methylene blue dye was used as the leakage marker for this study because:

It has a low molecular weight and penetrates more deeply than other dyes along the root canal filling. It is readily detectable under visible light, diffuses easily, not adsorbed by the dentinal matrix apatite crystals.

Its molecular size is similar to that of bacterial by-products such as butyric acid, which can leak out of infected root canals and irritate the periapical tissues. Dye penetration is the

method most widely used (due to its simplicity) to evaluate the apical seal of root canals. Five percent (5%) solution of methylene blue dye was used as a leakage marker.[9]

Linear measurement of the most coronal extent of dye penetration on the wall was used to evaluate the sealing ability of the root canal sealers.

In 82% of leakage studies in endodontics, dye or radioisotope penetration methods have been used. Matloff et al. showed that methylene blue dye penetrates far further into the canal than isotope tracers, thus giving a better representation of apical leakage.

The tooth roots were grooved bucally and lingually with a diamond disc, ensuring that the root canal filling was not penetrated, and then they were split into halves with diamond disc attached to a micro motor hand piece. The linear extent of dye penetration from the apical to coronal root ends was measured using a stereomicroscope (x12 magnification) and a metric rule. The longitudinal sectioning method enables examination of the exposed filling materials and any dye penetration into the material at the interface of the dentinal wall .[10]

This study evaluated the ability of a three root canal sealers (iRoot SP, AH Plus and Vitapex) to seal root canals prepared with the ProTaperNiTi rotary instruments using methylene blue dye penetration methods. Under the condition of this in vitro study leakage in teeth obturated with Vitapex showed the highest mean leakage (2.2793mm) which was followed by AH Plus (1.4997mm), while group sealed with iRoot SP showed the lowest mean (0.7777 mm) leakage. The positive control group showed dye penetration into the canals and the negative control group did not demonstrate dye penetration.

Possible reasons for the result could be that iRoot SP is based on a calcium silicate composition, which does not shrink on setting and hardens in the presence of water.[11] In a study conducted by Emre Nagas showed that iRoot SP showed the highest bond strength to dentin because of its extremely small particle size and excellent level of viscosity ,which enhances the flow of these material into dentinal tubules,anatomic irregularities and gutta percha.[12]

The difference between the mean linear dye penetrations between. Groups I, II and III were statistically significant. Group III showed least dye penetration compared to group II and III. It can be concluded that iRoot SP was superior to AH Plus and Vitapexsealer in apical sealing ability. In addition, however, further studies are needed to clarify the long-term sealing ability of this new material as well as evaluate its clinical performance.

Table-1 Leakage of root canal fillings - Mean and ± SD (in mm) of all groups

Group	N0.of teeth	Mean	Std.Deviation
I-iRoot SP	30	0.7777	0.55443
II- AH Plus	30	1.4997	0.90061
III- Vitapex	30	2.2793	0.78322
Total	90	1.5189	.97190

Table 2 Shows amount of dye penetration in positive and negative control group.

SPECIMEN NO:	Group IV POSITIVE CONTROL	Group V NEGATIVE CONTROL
1	16	0
2	12.5	0
3	14	0
4	12	0
5	14.4	0
Range	12-16	0
Mean	13.78	0
± SD	1.59437	0

Conclusion:

Within the limitations of this study, it can be concluded that iRoot SP demonstrated superior sealing ability compared to AH Plus and Vitapex. The enhanced performance of iRoot SP may be attributed to its bioceramic composition, which allows for excellent adaptation to the canal walls, expansion upon setting, and superior bioactivity. AH Plus, an epoxy resin-based sealer, showed satisfactory sealing properties but was inferior to iRoot SP. Vitapex, while convenient for certain clinical situations, exhibited the least effective seal among the three tested materials, likely due to its resorbable nature and weaker adhesion to dentin.

These findings suggest that bioceramic sealers such as iRoot SP may provide a more effective long-term seal in endodontic treatment, potentially improving clinical outcomes. Further in vivo studies and long-term clinical evaluations are recommended to confirm these results and assess the clinical relevance of the sealing ability observed in vitro.

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