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Evaluation sealing ability of a new polydimethyl siloxane sealer

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Abstract
The main aim of root canal therapy is the removal of microbial contaminants in conjunction with the total closure of the root canal system. Root canal sealers along with solid core material plays a major role in achieving the three-dimensional sealing of the root canal system. These sealers are binding agents which are used to adapt the rigid gutta-percha to canal walls and to fill up the voids, accessory canals and irregularities within the canal. Root canal sealers, although used only as adjunctive materials in the obturation of root canals, have been shown to influence the outcome of endodontic treatment. A perfect combination of sealing ability and biocompatibility is what an ideal root canal sealer should possess. This article discusses the current concepts in the usage of different sealers in endodontic therapy and their comparison in order to draw some clinical inferences.

Keywords: Endodontics; Root canal treatment; Sealers, apical leakage, stereomicroscope.

Introduction
The method most frequently employed for the obturation of root canal system is a semisolid, solid or a rigid core material cemented in the canal with a root canal sealer. Obturation of the root canals by using gutta-percha is widely accepted. Gutta-percha does not bond to root dentin therefore must be used with a sealer cement and a sealer must adhere firmly to both root canal wall and the core material to improve sealing ability of the filling [1]. Objective of providing the fluid tight seal is achieved by a sealer. Sealer can be made to flow and fill the accessory canal and multiple apical foramina before the it sets. The long-term seal of a root filling is affected by both the amount of sealer used to fill the canal and the ratio of sealer to gutta- percha [2]. the criteria outlined by Grossman in 1988 for an ideal sealer. The sealers not be toxic; they should remain dimensionally stable on setting; they should provide adequate working time for manipulation and placement into the root canal; they should have adhesion, sealers also should be visible on radiographs; they should not cause staining of the crown of the teeth; they should not encourage bacterial growth; they must create and maintain a seal apically, laterally and coronally; they should be soluble in a solvent when retreatment is necessary but they should not disintegrate when in contact with tissue fluids [3].
This study is done to evaluate the sealing ability of the new polydimethyl siloxane sealer (Nanao Seal S).

Aim
To investigate the effective of the apical seal obtained by used in conjugation with cold lateral condensation technique of obturation using gutta percha. The *in vitro* stereomicroscopic study was done to evaluate effectiveness of sealing property of the new endodontic sealer (Nano Seal S) conducted in the Department of Conservative Dentistry and Endodontics. 30 single rooted extracted human permanent teeth with a single root canal were selected.

Fig 1: Nano Seal-S

Materials and Method

The teeth were stored in 1% sodium hypochlorite (NaOCl) solution, for three days to remove organic debris and then they were stored in distilled water. The crowns were removed at the cement-enamel junction using a high-speed fissure bur. Access preparation was done using an endo-access bur (Dentsply Maillefer, USA) and a barbed broach (Dentaire, SA) was used to remove the pulp. Then, a no.10 - K-file (Mani, Japan) was introduced into the canal and was pushed towards apical part until the tip of the instrument was just visible at the apical foramen. This length of the file was recorded and then after subtracting 1mm from the recorded length, working length of the root canal was determined The canals were cleaned and shaped with K-files (Mani, Japan) using a step-back technique with recapitulation of files to establish a progressively tapering root canal preparation. The apical portion of the canal was enlarged to a minimum 30 no. K-file and 50 no. K-file, depending on the size of the original canal. The coronal two thirds of each canal were prepared using number 2 and 3

Gates Glidden drills (Mani, Japan) and apical third were prepared with hand files. After each instrument was used, the canals were irrigated with 2ml of 5% NaOCl and 2ml of 15% solution of EDTA (Dental Source, North Hollywood CA, USA). The irrigating solutions were delivered through a 25-gauge needle which was placed as far as possible into the canal without allowing the needle to touch the canal walls. The total amount of irrigant used in each canal was 30 ml, on completion of the instrumentation process, a 10 no. K-file (Mani, Japan) was passed 1mm through the apical foramen to remove any dentinal plugs and to ensure that the foramen was patent for dye penetration.

After drying the canals with paper points, standardized gutta-percha cones (Dentsply, China) were selected as master points. The fit of each master point was assessed by radiographs to determine whether the point was fully seated to the working length. The teeth were randomly selected and divided into three groups of 10 teeth each (four experimental group and one control group).

The sealers used were as follows

Group I – Conventional Zinc-Oxide Eugenol.

Group II – NanoSeal S (Silicon based)

Group III – Control Group- Gutta-Percha alone (no sealer).

All the teeth except the controlled teeth were filled with a root canal sealer and gutta-percha points using the cold lateral condensation technique. In the control group, sealer was not used.

The sealers were mixed according to the manufacturer's directions and were introduced into the canal using a lentulo-spiral (Mani, Paste carriers, Japan) which was kept 3mm to 4mm short of the working length. This process was repeated twice to ensure that an adequate amount of sealer was placed in each canal. The master gutta-percha point (Dentsply, China) was coated with sealer and placed in the canal to the full working length.

Hand spreader (Dentsply, China) was then used for lateral condensation with standardized fine gutta-percha accessory points (Dentsply, China) was carried out until the entire canal was obturated. Excess gutta-percha was removed and the gutta-percha in the coronal third of the canal was vertically condensed with a plugger. Radiographs were taken to evaluate the obturation. Obturation was considered to be optimum when no voids were present in the radiograph. If the voids appeared in the radiograph, re-obturation was done.

The access cavities were sealed with Cavit G (3M ESPE, Germany) up-to 2 mm and the teeth were placed in a Humidifier (ICU Safe, Sanyo, Japan) for 1 to 3 weeks with 100% humidity at 37□C to ensure that the sealer set in an environment that simulate the clinical situation in which they are designed to be used.

The roots were coated with two layers of clear nail varnish (Lakme, New York) except for the apical 2 to 3 mm. At this stage the control group was further sub-divided into two equal groups, the positive and negative controls. Teeth in the positive control group had the roots coated with nail varnish (Lakme, New York) except for the apical 2mm to 3mm in the same manner as the experimental groups. They were used to test the sealing ability of gutta-percha when used without a sealer. Teeth in the negative control group had the entire root surface coated with nail varnish and were used to test the ability of the nail varnish to seal the root against dye penetration under the experimental conditions used in this study.

Once the nail varnish was absolutely dry, each sample was introduced in a 12-ml centrifuge tube with the apex of the root positioned in the direction of the open end of the centrifugal tube. Methylene blue dye solution 2% (pH=7) was poured into each tube until the root was completely immersed into the solution. The samples were then centrifuged for 3 minutes at 30Xg using a centrifugal machine. The samples were taken out from the solution and were thoroughly bathed in running tap water.

The experimental samples were sectioned longitudinally by means of a low-speed circular diamond saw (Confident, India) in a path roughly parallel to the axis of the tooth and through the apex with a coolant. After sectioning, the samples were studied under a stereomicroscope (32X Magnification, Carl Ziess). The end point of dye infilteration was calculated as the point where dye no longer penetrated the obturating material. The measurement from the apex to the end point of dye penetration was observed and documented in millimeters [Table/Fig-1].

Fig 2: Dye penetration

[Fig-2]: The specimens were examined under a stereomicroscope (X32 magnification, Carl Ziess) and the end point of dye penetration was determined as the point where dye no longer penetrated the filling material. The distance from the apex to the end point of dye penetration was measured and recorded in millimetres.

Statistical analysis
For the analysis of data Students t-test for the quality of variances among the experimental group and control group (One-Way ANOVA) were employed.

Results
Descriptive statistics of mean dye penetration values (in mm) for each group showed that dye penetration is maximum in Group III and minimum in Group I [Table 1]. Students t-test for the equality of variances among the experimental group and control group (One-way ANOVA) which is Significant ($p<0.01$) [Table 2].

Discussion
To ensure long term clinical success the entire root canal system should be filled three dimensionally following thorough cleaning and shaping of the root canal. The concept of a perfect apical seal has led to search for filling and sealing materials that are stable, non-irritating and provide a hermetic seal at the apical foramen. The selection of sealers is dependent on its capacity to create a comprehensive seal but it must also be well accepted by peri-radicular tissues and be comparatively easy to manipulate so that its optimum physical and biological properties can be clinically achieved. In principle the core material should push the less viscous into unreachable areas such as canal anastomosis, apical delta and into irregularities produced through canal preparation [4].

Table 1: Descriptive statistics of mean dye penetration values (in mm) for each group.

Groups	Sealers	N	Mean	STD Deviation
I	NanoSeal-S	10	0.8200	0.24
II	Zinc-oxide eugenol	10	0.8700	0.94
III	Control No sealer	10	1.500	1.38

Root canal sealers have been studied and it has been found that dissimilar constituents seal the canal to different extents [5]. The aim of canal cleaning and shaping is to eliminate all pulp material remnants and bacteria along with their substrates and optimum shaping of the root canal space [6]. The current method used in canal obturation employ a semisolid, solid or a rigid core material cemented in the canal with a root canal sealer that acts as apical sealing agent, binding agent to the well adapted master cone into a canal, filler for the intricacies and minor disagreements between the cones and canal space, lubricant to enable the placement of the gutta-percha into the canal. Hence, this study was carried out to evaluate the sealing effectiveness of different root canal sealers by calculating the apical dye leakage [7].

Table 2: ANOVA

score	Sum of the squares	DF	Mean square	F	Sig.
Between Groups	6.300	2	3.1	2.5	0.96
Within Groups	70.850	58	1.3		
Total	77.000	60			

The leakage was minimum with Nanoseal-S sealer and maximum with conventional control group. Nanoseal -S sealer has the better sealing ability than the other sealers used in this study when used in conjugation with cold lateral condensation using gutta-percha.

The setting mechanisms of zinc oxide eugenol based cements is the outcome of equimolar mixtures of zinc oxide and eugenol, consisting of zinc oxide involved in an extended crystal matrix of zinc eugenolate chelate and is degenerated by the carbon dioxide which is present as bi-carbonate ions in the peri-radicular area and makes zinc-oxide eugenol a feeble and unbalanced cement [8].

The reason for less amount of leakage with Nanoseal-S could be attributed to the fact that it is insoluble. The second possible reason would be due to the slight expansion that might occur tending to wedge the sealer more tightly into the prepared root canal, thereby improving the mechanical interlocking. A study reported an expansion of RSA to be 0.2% [9].

Limitation
The method has to be done on larger sample and *in vivo* analysis should be performed to confirm sealing ability of newer endodontic sealers.

Conclusion
In vitro leakage studies comprise a major portion of contemporary endodontic research, yet it is difficult to draw *in vivo* correlation The result of these studies should be regarded as showing a theoretical maximum amount of leakage, which may or may not occur, in-vivo, and as such, they are probably good indicators and potential for consideration of success or failure of the treatment.

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