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Research Article

A Comparative Evaluation of Microleakage of Nano Sealer and Tricalcium Silicate Based Sealer with Two Different Obturation Techniques: An *In Vitro* Study

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Abstract

Aim: The aim of the study is to compare the apical sealing ability offered by Nano sealer and Tricalcium Silicate Based Sealer when used with Single Cone and Thermoplasticized obturation technique.

Materials and Methods: A sample of forty extracted upper central incisors were selected and were decoronated at the Cemento-Enamel Junction. Working length was determined using #15 k-file and the root canals were prepared using ProTaper Gold rotary file system till F3 size. The outer surface of the samples were coated with 3 layers of nail varnish except at the apical foramen for the dye penetration. The samples were randomly divided into four groups (n = 10) according to the root canal sealer and obturation technique used. The samples were immersed in 2% methylene blue dye for 72 hrs. The samples will be longitudinally sectioned and will be examined under stereomicroscope for microleakage evaluation, followed by scanning electron microscope for potential sealer penetration.

Statistical Analysis: Statistical analysis were performed using two-way-ANOVA test. The level of significance was set to $p < 0.05$.

Results: According to the results obtained, thermoplasticized obturation technique led to reduced microleakage. Moreover, dye penetration values were reduced for tricalcium-silicate based sealer.

In terms of microleakage, thermoplasticized obturation technique seems promising when combined with tricalcium silicate based sealer.

Keywords: Nano Sealer; Tricalcium Silicate Based Sealer; Single Cone; Thermoplasticized Obturation; Microleakage

Introduction

Root canal obturation plays a crucial role in endodontics, as it provides a proper apico-coronal seal by preventing the ingression of bacteria. Factors such as inadequate root canal debridement, inadequate or over extruded root filling material, failure of apico-coronal seal, root canal complexities, and procedural errors will determine the success or failure of root canal treatment [1].

Obturation is carried out by conjunction of Gutta-percha (a core filling material) and a fluid sealer. It includes various techniques. Most commonly used are cold obturation techniques and warm vertical compaction techniques. A tight apical seal is achieved by using warm obturation techniques, but whereas in cold obturation techniques, it is fully dependent on the root canal sealer [2].

Gutta-percha is a stiff material that will not adhere to the canal wall and will shrink after cooling which creates space for bacterial ingression. Since the space must be filled between tooth and gutta-percha, there is a need for root canal sealer for better adaptability [3,4].

Endodontic treatment failures are mainly due to failure of improper apico - coronal seal, which leads to ingress of micro-organisms and tissue fluids into canal space and thereby causing the microleakage [1].

A more biological approach has gained traction in recent years with the development of Tricalcium Silicate-Based Root Canal Sealers because of their excellent biocompatibility with modest expansion after setting, it improves adherence to root dentin [2].

Nanotechnology is the study of analysing and creating materials at nano dimensions by relocating atoms to create materials with superior qualities [5].

NanoSeal-S is a self-curing, antimicrobial root canal sealant with a polydimethylsiloxane base that contains nanosilver particles [6].

This *in vitro* study compares the micro leakage and apical sealing abilities provided by Tricalcium Silicate-based sealers and nano sealers when utilized in conjunction with single cone and Thermoplasticized obturation procedure using dye penetration technique

Materials and Methods

40 extracted maxillary central incisors (n = 40) were selected for the study. Exclusion criteria include teeth with resorption, open apices, fractures, or caries. Prior to usage, the samples were washed with a scaler to remove the debris, and then placed in 0.4% chloramine T aqueous solution. The samples were decoronated at CEJ using a diamond disc under constant water supply, resulting in a standardized root length of 12mm. Initial working length was established by using no.15 k file and root canal instrumentation was done by using ProTaper Gold rotary files (Dentsply Maillefer, Ballaigues, Switzerland) with ample irrigation of 5.25% NaOCl solution.

All the root canals were prepared to F3 size, till the working length. The smear layer removal wasdone by irrigating the canals with 5mL 5.25% NaOCl and then 5mL of 17% ethylenediaminetetraacetic acid (EDTA) for 60s. later irrigating the samples with distilled water will prevent the prolonged effects of EDTA and NaOCl. Drying of canal was done by paper points.

Apical foramen patency was confirmed by using size 25 k-file, and the outer surfaces of the samples were then coated with three layers of clear nail varnish.

The samples were randomly split into four groups (n = 10) based on the root canal sealer and obturation method used.

Group 1: Single-cone technique with nano sealer

In this group, ten samples were chosen. Radiovisiography was used to confirm the tug back and length of the master cone (#30.06) in the root canal. Following the canal's drying, the sealer (NanoSeal-S, Prevest Denpro) was produced according to the manufacturer's instructions. After that, a master cone was coated with sealer and gradually inserted into the working length to allow the sealer to flow back coronally and prevent apical extrusion.

Group 2: Single-cone technique with tricalcium silicate-based sealer

This group (n = 10) employed Tricalcium Silicate-Based Sealer (BioRoot RCS, Septodont SAS, Saint- Maur-des-Fosses, France). The mixing of the Sealer was done under manufacturer guidelines. Later, a single cone was coated with sealant and carefully placed into the canal.

Group 3: Thermoplasticized obturation technique with nano sealer

In this group, a freshly mixed sealer was applied to the canal walls, and a 23-gauge needle with a rubber stopper attached 4-5mm short of the working length was selected and placed into the Obtura-II cannon. The cannon was filled with a new gutta percha pellet. The needle was placed into the canal and 3-4 mm of gutta-percha was passively expressed into the channel once the display indicated that the Obtura-II unit had reached 200 °C. Apical GP was then compressed under verticalpressure using an endodontic plugger. To prevent shrinkage of GP after cooling, 3-4 mm increments were placed sequentially, with compaction performed after each step. The pulp chamber was cleared of extra GP.

Group 4: Thermoplasticized obturation technique with tricalcium silicate-based sealer

In this group (n = 10) Thermoplasticized obturation along with the Tricalcium Silicate-Based Sealer (BioRoot RCS, Septodont SAS, Saint-Maur-des-Fosses, France) was used.

Each group's teeth were kept at 37°C and 100% humidity for 72 hours after the access cavities were filled with Cavit to verify that the sealer had fully set.

The coronal surface of the roots were coated with three further coats of nail polish, submerged in 2% methylene blue dye, and incubated at 37°C for 72 hours. The roots were thoroughly rinsed under tap water after being exposed to the dye. Using diamond disc in a buccolingual orientation and through the apex, the experimental teeth were longitudinally sectioned to reveal the root canal space.

Sectioned samples were put on a sheet of millimeter paper and magnified 20 times using a digital stereomicroscope for examination. The distance (mm) from the most coronal site of dye infiltration to the apical foramen was measured to calculate the microleakage.

Following a microleakage assessment, corresponding tooth samples from each experimental group were dehydrated in ethyl alcohol at increasing concentrations (70, 80, 90, and 100%) before being sputter-coated with a 300-A -thick gold layer. Following

that, they were examined under SEM at magnifications of 1000x and 3500x to see whether the sealer had penetrated the dentinal tubules.

Statistical Analysis

Each experimental group's means and standard deviations were computed. The two-way analysis of variance (ANOVA) was used to evaluate the differences between the means to assess the influence of the two factors under discussion (the "endodontic sealer" and the "obturation technique") on the mean values for microleakage. For multiple comparisons, the Tukey Test was utilized. The level of significance in each test was set at $p < 0.05$.

	N	Mean	Std. Deviation	Std. Error	95% ConfidenceInterval for Mean		Minimum	Maximum
					Lower Bound	UpperBound		
Single Cone Nano Sealer	10	3.5400	0.12649	0.04000	3.4495	3.6305	3.50	3.90
Single Cone Tricalcium Silicate Based Sealer	10	2.6900	0.16799	0.05312	2.5698	2.8102	2.45	2.90
Thermoplasticized Nano Sealer	10	1.8300	0.70875	0.22413	1.3230	2.3370	0.70	2.60
ThermoplasticizedTricalcium Silicate Based Sealer	10	1.2500	0.46007	0.14549	0.9209	1.5791	0.50	1.80

Table 1

Figure 1

Results

The mean values (and standard deviations) of microleakage obtained are categorized according tothe components under consideration (endodontic sealer and obturation method) (Figure 1).

- When compared to the other experimental groups, Group 1 (NanoSeal S with single conemethod) had the greatest mean microleakage values (3.54 mm).
- When compared to the other groups examined, Group 4 (Tricalcium Silicate-Based Sealer andThermoplasticized Obturation Technique) had the lowest mean values (1.25 mm).
- The difference between Group 2 (tricalcium-silicate-based sealer and single-cone method) and Group 3(Thermoplasticized obturation technique and Nano Sealer) was statistically significant.
- Under SEM, dentinal tubular penetration of the BioRoot RCS is higher when compared to NanoSeal - S.

Figure 2: SEM images of ((A), at 1000x magnification (B), at 3500x magnification) sample obturated with a Nano sealer and Thermoplasticized obturation, dentinal tubules appearing empty.

Figure 3: SEM images of ((A), at 1000x magnification (B), at 3500x magnification) sample obturated with Tricalcium Silicate Based Sealer and Thermoplasticized obturation, Dentinal tubular penetration of sealer penetration is observed.

Discussion

One of the primary goals of endodontic therapy is the three-dimensional closure of the root canal system, which is crucial in maintaining healthy periapical tissues and avoiding canal re-infection [11]. Although GP is a root canal filling material of the highest calibre, it alone cannot achieve the proper adaptation to the root canal system leaving voids. sealers are used in conjunction with GP to provide three – dimensional hermetic seal [2].

The goal of this study to evaluate the sealing ability and microleakage of Nano Sealer (NanoSeal-S) and Tricalcium Silicate-Based Sealer (BioRoot RCS) with single cone and Thermoplasticized obturation technique by methylene blue dye penetration method with the help of stereomicroscope and tubular penetration with the help of SEM.

Microleakage is of two types, either coronal or apical, is caused by the GP shrinking and the root filling materials not adhering to the dentinal root canal walls [1]. The apical microleakage may be assessed using a variety of techniques, including bacterial infiltration, fluid infiltration, radioisotopes, electrochemical approaches, and dye penetration [11].

Because of its ease and speed, the dye penetration approach was used for this investigation. The frequentlyused dyes are Indian ink, Methylene blue, Rhodamine B, Crystal violet, and Basic Fuschin [1].

Due to its easy detection under visible light, water solubility, diffusibility, and hard tissue non-reactivity, methylene blue is utilised as a leakage marker. According to Matloff., *et al*. radioisotopes were less effectivein penetrating obturated root canal spaces than aqueous methylene blue dye [4].

This study used nano sealer (NanoSeal - S) and Tricalcium silicate-based sealer (BioRoot RCS) which are biocompatible, anti-

bacterial, and nontoxic to the body tissue, insoluble in tissue fluid, radiopaque and easyto use, stable and provide good adhesion.

In the present study, the highest dye penetration values were observed from Group 1, Nanosealer with single cone technique. The disadvantage of a single cone approach is the inability to obturate with sufficient homogeneity, which results in the creation of voids [2]. NanoSeal - S is a polydimethylsiloxane-based, self-curing, antibacterial root canal sealant that is also cold flowable. According to a research by Yullainda (2015), the polydimethylsiloxane sealer, which contains nanoparticles of gutta-percha, reportedly expanded above its capacity when heat was applied, causing shrinking and lead to the gaps in the root canal obturation [7].

Group 4 had the lowest dye penetration values (Tricalcium Silicate Based Sealer and Thermoplasticized Obturation Technique). To avoid void formation, the Obtura-II procedure employs GP pellets that are put in a delivery gun and heated to a temperature of 200^0 C before being injected into the root canal space [8]. Tricalcium Silicate-Based Sealer (BioRoot RCS) has a particle size of 1.4, allowing it to enter into dentinal tubules with a diameter of 2.5, and the sealer's strong flow allows it to penetrate deep into lateral accessory canals and even dentinal tubules [7].

According to Ashwini., *et al*. (2020), a Tricalcium Silicate-based sealer (BioRoot RCS) demonstrated the highest resistance to microleakage due to superior mechanical (dimensional stability, flexural and bond strength) and biological properties (biocompatibility and Osseo conductive) that contribute to superior sealing ability [1].

Conclusion

Within the constraints of this *in vitro* investigation, it can be concluded that Thermoplasticized obturation technique with the BioRoot RCS showed the least microleakage, where as the highest microleakage was in single cone with NanoSeal - S.

Under SEM analysis there is an evident penetration of BioRoot RCS into the dentinal tubules than NanoSeal-S

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Nil.

Conflict of Interest

Nil.

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