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# Density comparison of root canal obturation at apical one-third between single cone and downpack-backfill techniques using polidimetylsiloxane sealer

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**Abstract.** This study aimed to to compare the apical sealing ability in one-third apex between single cone (SC) and downpack-backfill (DB) techniques, using polydimethylsiloxane sealer. Forty extracted human mandibular premolars were divided into two groups: SC and DB. After they were obturated with polydimethylsiloxane sealer, the samples were stored in an incubator, coated with nail varnish, immersed in India ink, and then the specimens were cleaned, using Robertson's technique. The apical dye penetration was evaluated using a stereomicroscope. The lowest leakage score (0–0.5 mm) was found in the SC group and the highest score (>1 mm) was found in the DB group. The single cone technique exhibited better sealing ability than the downpack-backfill technique, although there was not a statistically significant difference between these two techniques.

## 1. Introduction

The main objective of an endodontic is to remove pulp tissue, debris, bacteria, and its byproducts from the root canal system [1]. The sealability of the root canal after the cleaning and shaping is important in order to prevent oral pathogens from colonizing and reinfecting the root canal and its periapical tissue [2]. Inadequate root canal obturation was the biggest cause of endodontic treatment failure (45%), followed by a missed canal (32%), and failed restoration (14%) [3]. Thus, the success of the endodontic treatment was strongly influenced by the root canal obturation [4].

Obturation is important to maintain the long-term health of the periapical tissue [2,5]. Sealer for the obturation material is highly necessary to prevent bacteria from entering the root canal and forming monoblock bonding. The monoblock concept is theoretically related to genuine gap-free sold filling mass, which enables the formation of a fluid-tight seal. Nevertheless, clinically, it has been difficult to establish monoblocks in obturation; as a result, endodontic failure is closely related to obturation leakage [4,6].

Gutta-percha has been known and used in dentistry for more than 150 years, and its use with a sealer is a standard procedure in endodontic treatment [4,7]. Generally, the gutta-percha obturation technique is done after use of a cold, lateral, condensation technique. In 1967, a warm, vertical, condensation technique arose as an alternative to the cold, lateral, condensation technique [7]. This technique was considered to be able to produce adequate gutta-percha adaptation toward the root canal wall, including the wall the root canal s which have complex anatomy. Many studies recommended using thermoplastic

gutta-percha to obturate the root canal because it could produce a better, more homogenous adaptation, in comparison to the cold, lateral, condensation technique [8].

The single cone obturation technique has been trending lately, with the introduction of the gutta-percha cone that has a big taper and is suited for the use of a rotary Nickel-Titanium (NiTi) instrument [8]. This technique was quickly accepted and supported by the more developed obturation material. Currently, sealer material with a polydimethylsiloxane base had been observed as a potent material in tightly sealing the communication pathway between the root canal system and the surrounding environment [9]. In some research, it was reported that this sealer produced lower degrees of leakage, when compared to an epoxy sealer [10].

The continuous wave condensation technique was known to be able to provide an effective seal and to fill the lateral canal [8]. However, a different result was reported by Brackett *et al*., who stated that the sealing ability of the warm, compact, vertical obturation technique and the continuous wave technique, using AH Plus (an epoxy resin sealer), did not produce better results in comparison with the use of GuttaFlow (a polydimethylsiloxane-based sealer) and the single cone technique [11]. Another advantage of the polydimethylsiloxane sealer is that there is no need to use a condensation process for obturations with this product. As a result, further observation is needed to ensure whether or not the use of polydimethylsiloxane, in conjunction with the single cone technique, can achieve equal or better results than the use of the downpack-backfill technique, which is known as the best obturation technique today.

## 2. Materials and Methods

Forty mandibular premolars were extracted, cleaned, and rinsed in a 0.9% NaCl solution before the research began. All of the teeth were assessed and then prepared using root canal preparation with the crown-down technique using Mtwo (VDW, Germany) rotary instrument, for premolars 1–30. During preparation, the root canals were irrigated with 2 mL of 2.5% NaOCl for every instrument changing. After preparation had been completed, the root canals were irrigated with a 17% EDTA solution for one minute, rinsed with sterile water, irrigated with NaOCl 2.5%, and, lastly, were dried using paper point. After all of the samples were fully prepared, they were randomly divided into two groups: the single cone (SC) and the downpack-backfill method (DB).

For the SC root canals, the obturation was accomplished using the single cone technique. The master cone was coated in polydimethylsiloxane sealer and then inserted into the root canal and moved up and down in the root canal. Next, the gutta-percha cone was placed into the root canal to the point of the working length. The gutta-percha was then cut using a gutta cutter, 2 mm under the orifice. Meanwhile, on the DB group, polydimethylsiloxane sealer was inserted into the root canal, using a Lentulo spiral (Dentsply Maillefer, Switzerland). The master cone was inserted to the point of the working length. The coronal part of the gutta-percha was cut by a handpiece plugger (Elements, SybronEndo; Sybron Dental Specialties Inc., USA) until the gutta-percha remained 3–4 mm at the apical one-third, and then the vertical compaction was complete. After this, the two-third part of the corona was injected with warm gutta-percha from an extruder handpiece (Elements, SybronEndo; Sybron Dental Specialties Inc., USA) and filled up to 2 mm under the orifice. After every obturation had been finished, the coronal part was laminated with glass ionomer cement.

The samples were incubated for 24 hours at 37 °C with 100% density in a 0.9% NaCl solution to wait until set. The samples were then taken out of the incubator, dried with air spray, and then all of the tooth surfaces were laminated with two layers of nail varnish, except for 2 mm from the apical tip. After one day had passed, the samples were immersed in Indian ink, rinsed under running water, and the nail varnish was cleaned by a scalpel.

The processes of decalcification, dehydration, and transparency were completed using Robertson's method. During the decalcification stage, the samples were immersed in 10% nitric acid for the duration of three days. The solution was changed every day and shaken three times. On the third day, the samples were stabbed with a needle to ensure that the samples were tender enough. The samples were then rinsed in the running water for three to four hours. During the dehydration stage, the samples were immersed

in 70%, 80%, 95%, and 100% ethanol for 24 hours each. Next, during the transparency stage, the samples were immersed in 100% methyl salicylate for two hours at 37 °C, until they looked transparent.

The observations were completed using a stereomicroscope (Discovery V12, Carl Zeiss, AxioCam, Jerman) with a 20X zoom. The data taken was the color penetration distance from the apical foramen to the corona, measured by a millimeter grid. The penetration score was determined according to Pathomvanich's scale. The research data results were analyzed using a parametric, statistical Chi-Square test to examine the significant difference of each group with a significant limit ($\alpha$) = 0.05.

## 3. Results and Discussion

### *3.1 Results*

The total, forty samples in this research were divided into two groups—that is, group SC and group DB. The data taken was the Indian ink's penetration distance score into the root canal at the apical one-third, which was determined according to Pathomvanich's scale. The statistical analysis used was the Kolmogorov-Smirnov test, due to the fact that the data did not suit the Chi-Square test requirements since there were two cells (33.3%) with expected count scores of less than five. The apical one-third leakage score distribution between the SC and DB obturation groups are depicted in percentages in Table 1.

**Table 1**. Apical one-third score distribution in the sc (single cone) group and the db (downpack backfill) group

| Group test | Leakage Degree | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | Total | p |
| | n | % | N | % | N | % | | |
| **SC** | 12 | 60 | 2 | 10 | 6 | 30 | 20 | 0.791 |
| **DB** | 7 | 35 | 4 | 20 | 9 | 45 | 20 | |

N = Amount of samples
1 = 0–0.5 mm leakage at apical one-third
2 = 0.51–1 mm leakage at apical one-third
3 = >1 mm leakage at apical one-third

On Table 1 it can be seen that the SC group scored 60%, while the DB group scored 35%. For the second score, the SC group got 10%, and the DB group received 20%. For the third score, the SC group received a lesser percentage (30%) in comparison with the DB group (45%). The leakage degree percentage score was the percentage of each obturation technique group. From the statistical analysis, the comparison between the two groups resulted in a significance of p = 0.791. The conclusion implicit in Table 1 is that the SC group experienced less apical one-third leakage in comparison to the DB group, but the difference was not significant.

### *3.2 Discussion*

This research was done in order to observe the sealability obturation of polydimethylsiloxane sealer using the single cone and downpack-backfill techniques. The sealability quality was scored by measuring the degree of leakage, primarily on the apical one-third. The apical one-third area was the most susceptible to the leakage, as prior research stated that the leakage on the apical area contributed to the cause of failure for the majority of endodontic treatments (63%) [12]. This area is the most difficult area to clean, prepare, and obturate, because of the root canal's complexity with numerous lateral canal [13,14].

Table 1 reveals that the leakage on the apical one-third happened with every research sample , regardless of whether they had been obturated by the single cone technique or the downpack-backfill method. This result corresponded with the research of Hammad *et al*., who stated that was there was no

perfect root canal obturation without any gap [15]. From statistical analysis data obtained by the Kolmogorov-Smirnov test, the significance score (p), between the SC and DB groups, was 0.791 ($p > 0.05$). This means that the apical one-third leakage within the SC group was not significantly different from the DB group. As a result, the hypothesis was accepted that there was no difference in the degree of sealability in apical one-third obturations between the single cone technique and the downpack-backfill technique, using polydimethylsiloxane sealer.

Table 1 reveals that the SC group received an initial score of 60%, which was greater than the DB group's initial score of 35%. This implies that the least leakage score (0–0.5 mm from the apical) was demonstrated by the SC group. On the contrary, for the second and third scores, the DB group had the greater percentages of 20% and 45%, in comparison to the SC group's percentages of 10% and 30%. From the data given, it can be concluded that the sealability of the apical one-third obturation with the single cone technique was substantially better than the downpack-backfill technique.

In some previous research, it was reported that polydimethylsiloxane sealer had advantages in comparison to other sealers. Research by Eldeniz *et al*., showed that obturation with GuttaFlow (a polydimethylsiloxane sealer) was more resistant toward bacteria penetration in comparison with EndoREZ (a resin methacrylate sealer), RC sealer (a resin methyl methacrylate sealer), AH Plus (an epoxy resin sealer), Acroseal (an epoxy sealer containing calcium hydroxide), and RoekoSeal (a silicone-based sealer) [16]. Additional research by Savariz *et al*., also showed that the use of polydimethylsiloxane sealer was superior to epoxy resin sealer, when using the single cone and lateral condensation techniques [17]. Moreover, research conducted by Wu *et al.*, showed that obturation using polydimethylsiloxane sealer was capable of preventing liquid transportation on the apical area during the first year [12].

Polydimethylsiloxane sealer is a combination of sealer and gutta-percha in one material [7]. The ingredients of this sealer include polydimethylsiloxane matrices with gutta-percha filler powder and nano-silver. Some research has shown that this sealer is capable of producing excellent flow energy, with the physical properties matching ISO standards [18]. Unlike thermoplastic gutta-percha, which shrinks during the setting time, polydimethylsiloxane showed a light expansion of 0.2%. Moreover, this material has such a small particle size (<0.9 μm), allowing it to flow excellently into small, dentin tubuli [18].

Research by Yadav, Yada, and Sharma *et al*., revealed that GuttaFlow (a polydimethyl-siloxane sealer) had an excellent flow, particularly at 5 mm from the apical area, in comparison with obturation using the downpack-backfill technique [7]. This research did not score the sealer penetration ability into the accessory canal. However, from observation with a stereomicroscope, it can be seen that this sealer could enter the canal accessory well at the apical one-third, or even in the mid-one-third, even though the penetration was not distant. This is why the obturation leakage over the accessory canal occurred.

Root canal obturation is frequently used today, along with the development of the rotary NiTi instrument. Nevertheless, this technique is contradicted by the use of more root canal sealer in the procedure [14]. According to Pommel and Camps' (2001) research, root canal obturation, using the single cone technique with a ZOE-based sealer, displayed the highest degree of leakage in comparison with the lateral condensation, vertical condensation, Thermafil, and System B techniques [19]. Supported by the research of Robbeerecht *et al*., the obturation combination technique of the warm vertical and the liquid gutta-percha injections is better than the single cone technique [20].

This research obtained the result that the single cone technique resulted in high sealability scores at the apical one-third. This was in agreement with the research of Mithra *et al*., who concluded that obturation using the single cone technique, along with AH Plus sealer (an epoxy resin), had apical one-third sealability scores that were better than the lateral condensation technique [21]. Obturation results using the single cone technique were considered to be bad, since high levels of porosity occur in the sealer due to contraction and sealer dissolution. Nevertheless, this technique also had some advantages, having a shape that was suitable for the use of the rotary NiTi instrument, used for preparation on the root canal, which was suited to the root canal's shape as well. This prevented sealer extrusion apically, as the rigid gutta-percha cone shape fit the root canal and distributed the sealer better to the root canal

accessory. Condensation, as a shorter time procedure, diminished the lateral stress during obturation, which could result in overfilling and a root fracture, potentially causing damage of the tissue due to raised temperatures on the root surface [22].

For the purposes of this research, polydimethylsiloxane sealer was used in two different techniques, and it was found that, on the single cone technique, the leakage degree results were less than those of the downpack-backfill technique. This result is supported by research conducted by Kapoor *et al*., who stated that obturation using the single cone technique and GuttaFlow (a polydimethylsiloxane sealer) would result in a lesser degree of leakage at the apical one-third, in comparison to the downpack-backfill method, using AH Plus (a resin epoxy) sealer [23].

The higher leakage degree of the downpack-backfill technique results from the transformation phase of that obturation system. The warm application on the downpack backfill system resulted in a crystalline phase of the gutta-percha, which changed into an amorphous phase. The crystalline phase could only be reached during the extreme temperature freezing (0.5° per hour). Polydimethylsiloxane sealer contains gutta-percha particles so that heat application on this sealer would affect the ingredients of the powder gutta-percha. The reformation of the beta phase after obturation resulted in shrinkage and increased the gap toward the root canal wall [23].

Moreover, operator skills that have not yet mastered the heated gutta-percha technique with the downpack-backfill technique may also be contributing factors to a less controlled material, decreased measurement reference on the obturation, and less pressure while condensing the gutta-percha at the apical one-third [23].

## 4. Conclusion

In this research, both techniques used the single cone and the downpack-backfill methods, resulted in leakage at the apical one-third. The single cone resulted in a sealability degree of the apical one-third that was better than downpack-backfill method's results. Nevertheless, the difference between these methods was insignificant.

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