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Comparison of the Percentage of Voids in the Canal by Using Two different Obturation Techniques

Ravinder Kumar Bhagat[1], Ankush Jasrotia[2*], Kanchan Bhagat[3]

[1]Dental Surgeon, School Health Scheme, CMO Office, Reasi, Jammu, India.

[2]Dental Surgeon, Govt. SDH Hospital Akhnoor, India.
*Corresponding author

[3]Dental Surgeon, Indira Gandhi Govt. Dental College and Hospital, Jammu, India.

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Abstract

Background: This study evaluated the sealing ability of obturation technique in type II root canal through the comparison of the presence of voids between the single-cone technique using calcium silicate-based sealer and continuous wave compaction technique using resin-based sealer. **Methods**: This study used 30 extracted human maxillary single-rooted premolars that were instrumented with rotary nickel-titanium instrument and randomly assigned to two groups. The root canals were obturated with either single-cone technique using calcium silicate-based sealer or with continuous wave compaction technique using resin-based sealer. The presence of voids in the samples in mesio-distal directions were evaluated using radiographs. **Results**: There were more voids in the total volume and coronal third of the roots in the single-cone technique group than in the continuous wave compaction technique group. However, there was no significant difference in the percentage volume of voids in the middle and apical thirds of the roots between the two groups. Additionally, there was no significant difference between two groups with respect to external voids. **Conclusion**: Within limitation of this study, SC technique with calcium silicate-based sealer should be used very carefully in type II root canals.

Keywords: Continuous wave compaction (CWC), Root canal obstruction, Single-cone technique, Voids.

INTRODUCTION

The objective of root canal treatment is to clean and shape the pulp space, and totally obturate it with a filling material.[1] Appropriate root canal obturation prevents residual bacteria and their toxins from influencing the periapical tissue. One of the significant causes of endodontic failure is microleakage, which may happen between the gutta-percha and sealer. In numerous investigations, deficiently obturated teeth showed a higher chance of periapical lesion than those with adequate root canal filling.[2]

Gutta-percha is normally utilized with sealers to accomplish a fluid tight seal. Root canal sealers occupy the spaces between the gutta-percha cones, just as between the gutta-percha and root canal walls.[3] In this manner, the root canal obturation technique and sealing ability of the root canal sealer are important factors determining the success of the root canal treatment.

All obturation methods require a specific amount of root canal sealers to fill little space along the canal wall. Epoxy resin based sealers have been the highest quality level to date. A

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later advancement is addressed by calcium silicate-based sealers (CSS), which are derived from calcium silicate-based cements (MTA).[4] CSS are demonstrated to be biocompatible and bioactive. A hydroxyapatite-like precipitates structures on the outside of CSS when they interact with tissue fluid so these sealers are not perceived as foreign bodies, even in instances of sealer extrusion. After their setting, CSS discharge OH-and Ca2+ particles throughout a more drawn out timeframe through which they possibly display certain antibacterial effects and support the healing of periapical aggravation. Hence, thought has been given to filling root canals mainly with CSS and limiting the extent of guttapercha.[5]

Until now, notwithstanding, no drawn out clinical examinations have been performed to affirm the benefits of this new idea. In spite of the fact that gutta-percha has been effectively utilized for root canal obturation for seemingly very long time, there are alternate points of view as to which root canal filling technique is better: cold or warm (thermoplastic) obturation. After the exposure of adequately filled root canals with saliva, microorganisms consistently penetrate into the root canal system regardless to the obturation technique.[6] As of not long ago, no known obturation technique leads to a bacteria-proof sealing of the root canal. Subsequently, as far as clinical achievement rates, no predominance of the often suggested thermoplastic root canal filling procedure contrasted and cold lateral compaction could be illustrated. Generally speaking, CSS are not affirmed for thermoplastic obturation, as these sealers are water-based; there is the worry that high temperatures of up to 200 °C will eliminate a lot of water from the sealer, which can adversely affect its properties. It is problematic whether such high temperatures are clinically accomplished during thermoplastic obturation.

A hindrance of CSS is their higher solvency contrasted with epoxy resin sealers. In the long haul, this can prompt the disintegration of the root canal filling. In the investigations that have been performed to date, in any case, no distinction in the clinical achievement rates between epoxy resin sealers and CSS has been resolved. Generally speaking, CSS address an intriguing option in contrast to ordinary root canal sealers. On a basic level, the accomplishment of a root canal treatment depends on the obturation procedure, yet most importantly, on the total evacuation of the infected tissue, the lasting sanitization of the root canal system and the bacteria-proof post-endodontic restoration.[7]

On a basic level, the achievement of a root canal treatment depends on the obturation strategy, yet most importantly, on the total expulsion of the infected tissue, the permanent disinfection of the root canal system and the bacteria-proof post-endodontic restoration.

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Thus, the aim of this study was to evaluate the sealing ability in type II root canals by comparing the presence of voids between SC technique using calcium silicate-based sealer and CW compaction technique using resin-based sealer.

MATERIALS AND METHODS

This study included 35 extracted human maxillary single-rooted premolars with-out caries, root resorption, restorations, immature apices, or fractures. Preliminary periapical radiographs in mesio-distal directions were recorded to evaluate the anatomy of the roots of the teeth. After radiographic examination, all samples with Weine's type II root canal configuration were included, while three teeth with other root canal types and two with severely calcified canals were excluded.

The remaining 30 teeth were decoronated using a diamond burand each root was adjusted to 12 mm length. A size 10 manual K-file (DentsplyMaillefer, Ballaigues, Switzerland) was then inserted into the root canal until the file tip was just visible at the apex. The working length was set by subtracting 1 mm from this length.

All samples were shaped using Protaper Gold rotary instruments (DentsplyMaillefer) driven by a VDW motor (VDW GmbH, München, Germany) according to the manufacturers' instructions. The teeth were shaped using serial files from S1 to F2 with the crown-down technique. Final apical enlargement was performed using a size 30 or 35 manual K-file. During root canal preparation, irrigation was performed with 2 mL 1.5% sodium hypochlorite (NaOCl) delivered from a 3 mL syringe with a 27-gauge endodontic side-vented needle. Endo Activator (DentsplyMaillefer) was used for 1 minute with NaOCl solution, and 1 mL of 10% ethylenediaminetetraacetic acid (EDTA) was used for final irrigation. Following this, the root canals of each sample were dried with sterile paper points.

All samples were divided randomly into two experimental groups (n=15, each). Root canal sealers were prepared according to the manufacturer's recommendations.

Group 1 (SC group) used SC technique with Ceraseal sealer (Meta Biomed, Korea). A master gutta-percha cone that corresponded to the final instrumentation size was selected. Ceraseal sealer was injected into the root canal, and the master gutta-percha cone was inserted into the root canal with a gentle pumping motion. For better penetration of the sealer into the root canal, ultrasonic vibration was used in an indirect fashion. Any excess guttapercha and sealer was removed using a heat carrier.

Group 2 (CW group) The tip of the heat carrier was prepared to fit 3 to 4 mm short of the working length. A master gutta-percha cone corresponding to the final apical instrument size was adjusted until a tugback sensation was achieved. Its tip was then covered with the AH Plus sealer and inserted into the root canal with a gentle pumping motion. The heat plugger was inserted through the master cone with slight pressure up to the point 3 to 4 mm short of the working length. The power was turned off and the plugger was pushed apically for 10 seconds. An additional one second of heat application was done, and the plugger was extracted carefully. After removing the excess gutta-percha, thermoplasticized gutta-percha injection was performed with Duo Beta in the middle and coronal thirds of the root canal. The top portion of the gutta-percha in the coronal thirds was condensed with the hand plugger.

After the root canal obturation procedure, all samples were stored at 37°C at 100% humidity for 5 days to ensure setting of the sealer.

Radiographic image analysis

Radiographs of the samples in mesio-distal directions were recorded to evaluate the presence of voids. Each radiographic image was evaluated using ImageJ 1.50i (National Institutes of Health, Bethesda, MD, USA). Each sample was divided into three regions, starting from the apical end of the root: level of 0 to 4 mm (apical), 4 to 8 mm (middle), and 8 to 12 mm (coronal). For each region, the mean volume of the obturating materials and voids were calculated. Furthermore, the voids were classified as external voids (along the canal walls) and internal voids (inside the filling materials)

Statistical Analysis

The difference in mean volume of the obturating materials between the groups was compared using the student's t-test. Statistical analysis was performed using SPSS (version 18.0.0; SPSS Inc., Chicago, IL, USA). The differences were considered significant if the p-value was less than 0.01.

RESULTS

The mean volume (percentage±standard deviation) of the root canal filling materials (gutta-percha and sealer) and voids (external and internal) are summarized in [Table 1]. No specimen was free of voids, and occurrence of voids was unpredictable in all samples.

Table 1: Mean volume of the voids in the radiographs for the different regions

Area	Total Voids	External Voids	Internal Voids
Coronal Third			
SC	6.07±4.06	0.70±4.80	6.57±5.14
CW	0.81±1.10	0.07±2.11	0.78±0.15
Middle Third			
SC	4.25±3.49	0.80±3.75	3.51±3.27
CW	5.60±4.59	1.1±3.11	4.51±3.88
Apical Third			
SC	9.15±5.10	4.17±5.25	5.01±4.45
CW	9.83±5.87	3.87±4.38	5.65±4.65

The percentage of voids between the filling materials and root canal wall was not significantly unique between

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the two obturation techniques ($p > 0.05$), however SC group, which showed a fundamentally higher void volume in the coronal area of the canal ($p < 0.05$) However, no significant difference in the percentage volume of voids was found in the middle and apical thirds. There was no significant difference found between the two groups with respect to external voids. The SC group had more internal voids than the CW group in the coronal third and total volume of the root canal. Presence of external or internal voids showed no certain tendency. In the CW group, percentage of voids increased from the coronal thirds to the apical thirds, but decreased in the middle thirds and increased in the apical thirds in the SC group. In both groups, the ratio of external voids was highest in the apical third.

DISCUSSION

Radiography is the best way to assess the success of the root canal fillings in clinical circumstances. Besides, just bucco-lingual projection or some level of eccentric projection can be performed. Notwithstanding, a well obturated radiograph in the bucco-lingual projection can unveil imperfections, for example, voids that are likewise apparent in the mesio-distal projection.[9] Indeed, these imperfections were additionally identified by different strategies, for example, the dye penetration test, and consequently it is hard to assess the achievement or failure of the root canal treatment just through radiographic investigation in the bucco-lingual direction.

Ordinary bucco-lingual projection might be of restricted worthwhile assessing the nature of the root canal filling. Countless root canal fillings viewed as of good quality may really be deficiently sealed.[10] In this study, examination of root canal fillings between two different strategies was performed by radiographic investigation in the mesio-distal direction for more detailed information.[11]

Root canal filling material should prevent the penetration of microorganisms and toxins; however, there are chances of survival of microorganisms even after root canal treatment.[12] Residual bacteria can re-grow in the unfilled spaces, such as voids. Frequently, there are voids in the root canal filling materials known as internal voids, and could be considered less clinically relevant because bacteria, if present, are confined in an unfavorable environment. On the other hand, voids along the canal walls, known as external voids, could be a cause of re-infection, because they are in contact with potentially infected canal walls.[13] In this study, the percentage volume of external voids that could affect the success and failure of the endodontic treatment showed no significant difference between the two groups.

Celikten et al.[14] reported that the number of voids showed no significant difference in samples filled by the lateral compaction and Thermafil techniques, whereas void volumes were slightly higher in the SC technique group. They also reported that the bioceramic sealers (Endo-Sequence BC sealer and Smartpaste bio) produced similar voids, which were the smallest in the apical thirds of root canals among all the sealers tested. However, Moinzadeh et al.[15] reported that SC technique using calcium silicate cement produced lesser porosity than the lateral compaction method. In this study, the SC group showed more voids in the total volume and coronal thirds of the root canals than the CW group. No significant difference in the percentage volume of external voids was found in the root canal regions, but the internal voids were significantly larger in the SC group.

In this study, the SC group had more voids than the CW group in the coronal thirds. It is postulated that the wider root canal space, which does not allow a snug fit of the single cone, has higher potential for creation of voids. In other words, the more space left unfilled by the master cone, more the voids created. Therefore, the snug fit of the master cone along the prepared root canal space could be an important factor for successful root canal obturation when using the SC technique with calcium silicate sealer.
Improper and excessive pressure during root canal filling with CW compaction technique can lead to vertical root fracture and tooth loss.[16,17] SC technique may be less damaging to the tooth than lateral compaction and vertical condensation methods. Capar et al.[18] reported that the incidence of fractures using SC technique was lesser than that with conventional techniques, such as cold lateral and warm vertical compaction. Additionally, the SC technique was much faster to perform in clinical situations because of lesser procedures involved.

CONCLUSION

The SC group showed more voids as compared to the CW group in the total volume and coronal thirds of the root canal. Within limitation of this study, SC technique with calcium silicate-based sealer should be used very carefully in type II root canals.

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