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COMPARATIVE ANALYSIS OF POROSITY DISTRIBUTION IN ROOT CANALS OBTURATED WITH GUTTA-PERCHA AND BIOCERAMIC SEALER USING DIFFERENT OBTURATING TECHNIQUES

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ABSTRACT

Background: Achieving a hermetic seal by fill a cleaned and shaped root canal while performing obturation during an endodontic treatment procedure is of utmost importance to eliminate all portals of entry between the periodontium and the root canal so as to prevent the toxic product, tissue fluids percolation and recolonization of mcroorganism. The present study aims to evaluate and compare porosity distribution in root canals obturated with Gutta-percha and Bioceramic sealer using different obturating techniques. ***Materials and Methods:*** A total of 100 permanent single‑rooted human extracted teeth were divided equally into four groups based on the technique employed: Cold lateral condensation technique, Thermoplasticized obturaton technique, Single cone obturaton technique and Continuous wave compaction technique. Void volume was analyzed by Cone‑Beam Computed Tomography (CBCT) and void location was evaluated by microscopic method at three levels: coronal, middle, and apical. One way ANOVA and Chi‑square test were used for analyzing the obtained results. ***Results:*** When the void volumes as seen in CBCT images were compared, all the techniques showed comparable void volume ($p = 0.491$). The number of voids were lowest in Continuous wave compaction technique followed by Single cone obturaton technique, Thermoplasticized obturaton technique and highest in Cold lateral condensation technique. ***Conclusion:*** Continuous wave compaction technique creates least porosity in comparison to Single cone obturaton technique, Thermoplasticized obturaton technique and Cold lateral condensation technique.

KEYWORDS: Cone‑beam computed tomography, obturation, root canal, continuous wave compaction, single cone, thermoplasticized technique, cold lateral condensation.

INTRODUCTION

Classical biomaterials used in endodontic therapy are not intended to provide structural/mechanical reinforcement of the roots. Rather, root canal treatment biomaterials are typically biologically inert and have much lower elastic moduli than the tooth tissues that they fill. Their main purpose is to prevent root canal reinfection, providing favourable conditions for post-treatment recovery processes that are expected to take place in the living tissues surrounding the root. The ideal root filling material should have inert properties, good adhesive ability, and result in void‑free obturation along the root canals. Gutta‑percha is the most widely used obturation material due to its biocompatibility, inertness, dimensional stability, compactability, and ease of removal.[1-3]

There are different techniques that are used to obturate the root‑canal system. Cold lateral (CL) condensation is the most widely used and considered to be the gold standard technique.[4,5] In 1996, Buchanan created the continuous wave (CW) obturation technique, which was a modification of Schilder's warm vertical condensation technique. This obturation technique is considered less time consuming, provides less microbial coronal leakage, and adapts better to grooves and depressions of the canal walls and lateral canals than CL compaction.[6,7]

Various premixed injectable Endodontic sealers are developed for clinical convenience. CeraSeal RC sealer (Meta Biomed Co., Cheongju, Korea) is premixed second generation Bioceramic sealer. It is Calcium Silicate based root canal sealer, which has extraordinary insulator capabilities, biocomptability, anti-microbial activity, unique stability shorter setting time with no shrinkage and no exapansion. The wash-out phenomenon can happen if the MTA or MTA based sealer is not sufficiently cured or the exudates are produced in the root canal. Consequently, the root canal sealer is washed away by physical forces. CeraSeal prevents from wash-out phenomenon by curing faster than other sealers.[8]

The quality of root fillings is often determined by leakage tests and other more precise methods. Cone Beam Computed tomography (CBCT) can be applied for the analysis of root canal fillings, especially because of their non-homogeneous character and porosity. CBCT technique provides insight into the details of 3D images of fillings, especially voids and defects, at a level that is impossible to achieve with other methods.[9-10]

MATERIALS AND METHODS

Preparation of samples

After obtaining the ethical committee approval, a total of 100 single‑rooted permanent maxillary and mandibular human teeth extracted for therapeutic reasons and stored in 0.1% thymol at room temperature were used in the study. Teeth with complete root apex and single root canals as determined by radiographic examination were included, whereas the ones with root caries, root resorption, and calcified root canals were excluded. The crowns of the selected teeth were removed with a diamond disk mounted on a high‑speed handpiece to standardize the root length to 13 mm. All specimens were prepared by a single operator. An ISO size 10‑K file was placed inside the canal to determine the working length (kept 1 mm short of the full root canal length). The root canals were instrumented using ProTaper Universal Rotary instruments (Dentsply Maillefer) up to the #F3 file according to the manufacturer's instructions. The root canals were irrigated with 2.5% NaOCl after instrumentation with each file. At the end of the preparation, 3 mL of 17% EDTA solution was delivered into the root canal, and the solution was left in place for 3 min before flushing with 2.5% NaOCl. Finally, the canals were irrigated with distilled water to remove the remnants of the chemicals and were briefly blotted with paper points.

The prepared specimens were randomly allocated to 4 groups (25 teeth each) -Group 1: Cold lateral condensation technique, Group 2: Thermoplasticized obturaton technique, Group 3: Single cone obturaton technique and Group 4: Continuous wave compaction technique. A CeraSeal, Calcium Silicate-based Bioceramic root canal sealer (Meta Biomed Co., Cheongju, Korea) was used.

METHODOLOGY

The void volume was analyzed by both radiographic methods. Cone‑beam computed tomography (CBCT) scan of the mounted teeth was done using Planmeca ProMax 3D Mid unit 9 using the exposure parameters of 90 kV and 8 mA for 12 s to obtain a medium field of view (100 mm × 60 mm). Romexis software version 4.1.2 was used to assess the scans and void volume in each of the categories. Later, the sectioning of the tooth was done at three levels, namely apical, middle, and coronal using a diamond disk. The specimens were mounted on a slide and observed under a compound microscope to check the location of the voids. The images taken at every level were analyzed using the program "Image J" where the area percentage of each canal (CA) and the area percentage of each void (VA) were calculated.

Statistical analysis

The data was tabulated in Microsoft Excel and analysed with SPSS V.24 software. The void volume between the techniques was compared using one way ANOVA.The association of the void area percentage in relation to the various locations within the root canal was evaluated using the Chi‑square test. The p value≤0.05 was considered as statistically significant.

RESULTS

When the void volumes as seen in CBCT images were compared, all the techniques showed comparable void volume (p = 0.491).

Table 1 shows that prominent voids were seen in all the locations of the coronal section under different techniques. The number of voids were least in Continuous wave compaction technique followed by Single cone obturaton technique, Thermoplasticized obturaton technique and highest in Cold lateral condensation technique. But the difference in the association of the void volume in relation to the various locations between the four techniques was not statistically significant (p=0.229).

Table 2 shows that prominent voids were seen in all the locations of the middle section under different techniques. The number of voids were least in Continuous wave compaction technique followed by Single cone obturaton technique, Thermoplasticized obturaton technique and highest in Cold lateral condensation technique. And the difference in the association of the void volume in relation to the various locations between the four techniques was statistically significant (p=0.002).

Table 3 shows that prominent voids were seen in all the locations of the coronal section under different techniques except in the entire pulp under the Continuous wave compaction technique and Single cone obturaton technique. The number of voids were least in Continuous wave compaction technique followed by

Single cone obturaton technique, Thermoplasticized obturaton technique and highest in Cold lateral condensation technique. And the difference in the association of the void volume in relation to the various locations between the four techniques was statistically significant (p=0.015).

Table 1: Comparison of association of the void volume in relation to the various locations of the coronal section between the four techniques.

Techniques	Location	Count	Percentage	p value
Cold lateral condensation technique	Between cone	8	26.7	0.229
	Between cone and wall	8	26.7	
	Between sealer	6	20.0	
	Between sealer and cone	4	13.4	
	Between sealer and wall	4	13.4	
Thermoplasticized obturaton technique	Between cone	7	29.2	
	Between cone and wall	6	25.0	
	Between sealer	4	16.7	
	Between sealer and cone	3	12.5	
	Between sealer and wall	4	16.7	
Single cone obturaton technique	Between cone	6	27.3	
	Between cone and wall	6	27.3	
	Between sealer	4	18.2	
	Between sealer and cone	3	13.7	
	Between sealer and wall	3	13.7	
Continuous wave compaction technique	Between cone	5	31.3	
	Between cone and wall	4	25.0	
	Between sealer	3	18.8	
	Between sealer and cone	2	12.5	
	Between sealer and wall	2	12.5	

Table 2: Comparison of association of the void volume in relation to the various locations of the middle section between the four techniques.

Techniques	Location	Count	Percentage	p value
Cold lateral condensation technique	Between cone	7	28.0	0.002
	Between cone and wall	7	28.0	
	Between sealer	5	20.0	
	Between sealer and cone	3	12.0	
	Between sealer and wall	3	12.0	
Thermoplasticized obturaton technique	Between cone	6	31.6	
	Between cone and wall	5	26.4	
	Between sealer	3	15.8	
	Between sealer and cone	2	10.6	
	Between sealer and wall	3	15.8	
Single cone obturaton technique	Between cone	5	29.5	
	Between cone and wall	5	29.5	
	Between sealer	3	17.7	
	Between sealer and cone	2	11.8	
	Between sealer and wall	2	11.8	
Continuous wave compaction technique	Between cone	5	33.4	
	Between cone and wall	5	33.4	
	Between sealer	2	13.4	
	Between sealer and cone	2	13.4	
	Between sealer and wall	1	6.7	

Table 3: Comparison of association of the void volume in relation to the various locations of the apical section between the four techniques.

Techniques	Location	Count	Percentage	p value
Cold lateral condensation technique	Between cone	6	28.6	0.015
	Between cone and wall	6	28.6	
	Between sealer	4	19.1	
	Between sealer and cone	2	9.6	
	Between sealer and wall	2	9.6	
	Entire pulp	1	4.8	
Thermoplasticized obturaton technique	Between cone	5	33.4	
	Between cone and wall	4	26.7	
	Between sealer	2	13.4	
	Between sealer and cone	1	6.7	
	Between sealer and wall	2	13.4	
	Entire pulp	1	6.7	
Single cone obturaton technique	Between cone	4	33.4	
	Between cone and wall	4	33.4	
	Between sealer	2	16.7	
	Between sealer and cone	1	8.4	
	Between sealer and wall	1	8.4	
	Entire pulp	0	0.0	
Continuous wave compaction technique	Between cone	4	30.8	
	Between cone and wall	4	30.8	
	Between sealer	3	23.1	
	Between sealer and cone	1	7.7	
	Between sealer and wall	1	7.7	
	Entire pulp	0	0.0	

DISCUSSION

Clinically, the presence of gaps in root canal fillings is determined from the radiographic homogeneity of root canal filling biomaterials. The extent to which endodontic biomaterials are able to be seated and occupy the root canal volume has been investigated by a wide array of methods that have been so far unable to evaluate the sealing ability of the root canal filling in an objective and reproducible way. The use of quantitative and objective methods to evaluate the root canal treatment biomaterials and thus potentially lead to the improvement of clinical outcomes is still in sore demand. CBCT is a widely-used imaging tool capable of providing high-resolution 3D views of the internal structure of many objects and is well suited to visualize and evaluate the root canal filling non-destructively.[11-13]

In the present study, where predominant voids were observed at all the locations of the coronal and middle sections by the techniques, it was absent at the pulp area of the apical section by Single cone obturaton technique and Continuous wave compaction technique. The number of voids was found to be decreasing with the depth of obturation. And the number of voids were least in Continuous wave compaction technique followed by Single cone obturaton technique, Thermoplasticized obturaton technique and highest in Cold lateral condensation technique. These findings are similar to the findings reported by Kirk et al. (1999)[14] where the Continuous wave compaction technique was found to be significantly better than Single cone obturaton technique, Thermoplasticized obturaton technique and Cold lateral condensation technique. Kececi et al. (2005)[15] conducted a study to compare different combinations of root canal preparation and obturation technique. They reported that, continuous wave obturation was significantly faster than lateral compaction and total manipulation time in the continuous wave group was significantly shorter than the other groups.

For estimation of the quality of root canal filling, previously published studies have used either microscopic methodor radiographic technique. In the present study, CBCT was used for evaluation of the void volume as it helps in analyzing the porosity distribution 3D. Microscopic analysis was also carried out to locate the voids in relation to both the techniques at coronal, middle, and apical levels. This is because CBCT cannot differentiate between the sealer and the gutta‑percha, thereby failing to identify the voids between the same.[16-20]

CONCLUSION

The present study concludes that, Continuous wave compaction technique creates least porosity in comparison to Single cone obturaton technique, Thermoplasticized obturaton technique and Cold lateral condensation technique. Future research is recommended with the application of advanced technologies for meticulous examination of the porosities in endodontically treated teeth.

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