Evaluation of Homogeneity and Voids of Two Obturation Techniques using CBCT: An invitro study

Dr. Zunaid Ahmed, [1] Dr. Dr Meetu Mathur, [2] Dr. B.R. Adyanthaya, [3] Dr. Aastha Arora, [4] Dr. Nisha Gupta [5]

1. **Dr. Zunaid Ahmed**
   Senior Lecturer, Department of Conservative Dentistry and Endodontics, Rajasthan Dental college and Hospital, Jaipur, Rajasthan
2. **Dr. Meetu Mathur**
   Senior Professor, Department of Conservative Dentistry and Endodontics, Rajasthan Dental college and Hospital, Jaipur, Rajasthan
3. **Dr. B. R. Adyanthaya**
   Principal, Professor and Head of the Department, Department of Conservative Dentistry and Endodontics, Rajasthan Dental college and Hospital, Jaipur, Rajasthan
4. **Dr. Aastha Arora**
   Reader, Department of Conservative Dentistry and Endodontics, Rajasthan Dental college and Hospital, Jaipur, Rajasthan
5. **Dr. Nisha Gupta**
   Reader, Department of Conservative Dentistry and Endodontics, Rajasthan Dental college and Hospital, Jaipur, Rajasthan
6. **Dr. Khushboo Kachhwaha**
   Reader, Department of Oral medicine and Radiology, Rajasthan Dental college and Hospital, Jaipur, Rajasthan

CORRESPONDING AUTHOR
Dr. Khushboo Kachhwaha
Reader,
Department of Oral medicine and Radiology,
Rajasthan Dental college and Hospital,
Jaipur, Rajasthan
Email - drkkjpr@gmail.com

Abstract

Aims and objectives: to evaluate the voids and homogeneity of obturation of the root canals using two different techniques namely the lateral compaction technique, and single cone obturation.

Material and methods: 60 maxillary and mandibular first premolars which were freshly extracted for orthodontic purpose were collected and used for this study. The 30 samples in group 1 were obturated using Lateral Compaction technique. Another 30 samples in group 2 were obturated using single cone obturation technique

Results: The lateral compaction method is considered as better due to higher total volume percentage (82.25±6.56 at coronal third, 92.38±8.48 at middle third and 91.48±6.68at apical third) as compared to single cone obturation wherein total volume percentage (77.31±9.89 at coronal third, 83.53±8.27 at middle third and 87.01±8.79 at apical third)

Conclusion: Lateral Condensation technique had a lesser number of voids as compared to single cone obturation technique. Lateral condensation showed better homogeneity and qualityof obturation than by single cone obturation

INTRODUCTION

The most important goal of root canal treatment is the three dimensional obturation of canal space after removal of pulpal tissue.1 Three dimensional obturation of the root canal space helps to remove the cause of microleakage from the oral cavity and also from the peri radicular tissues into the root canal system.2

Microleakage in the root canal space occurs through various ways one of them is through the oral cavity into the tooth via the junction between the dentin and the obturation material or the root canal sealer. It can also occur due to the lack of adequate coronal as well as apical seal. When a perfect coronal as well as apical seal is achieved, the microorganisms present in the root canal are deprived of the essential nutrients needed for their growth and survival. Hence, one of the most important role of obturation is to provide a three dimensional hermetic/ fluid tight seal for the root canal space from both coronal and apical leakage.3

It has been reported in endodontic literature that in earlier times, root canals have been filled with a large variety of materials but all these materials which were used in the earlier times were not considered as the ideal root canal filling materials due to certain deficiencies in their properties as well as handling characteristics. Later, gutta percha gained acceptance and is now considered as ideal for this purpose.

Various modifications of gutta-percha have been made available. The form of gutta-percha which is used in the Lateral Compaction Technique is beta (β)form due to its improved properties such as stability, hardness and reduction in stickiness. The alpha (α) phase of gutta- percha is used in the thermoplasticized obturation techniques due to its low viscosity and flow properties resulting in a more homogenous root canal filling.4

There are various number of obturation techniques which are used such as Cold Lateral Condensation technique which is considered as the gold standard. Lateral condensation (compaction) of gutta-percha has been shown to be a successful technique if the adequate spreader depth of 1 mm is achieved apically. One of the potential shortcomings associated with Lateral Compaction is the relative poor replication of the root canal walls and the tendency to form voids as well as the creation of spreader tracts between the filled gutta- percha points.5 Certain defects such as voids, spreader tracts, incomplete fusion of the gutta- percha cones and the lack of surface adaptation have been reported with all the obturation techniques.6 All these defects can lead to failure of root canal treatment.

So to avoid the failure of procedure, quality of the root fillings can be assessed through different experimental approaches such as the acid dissolution of roots, electrochemical method, fluid filtration, dye penetration, radiovisiography, the SEM analysis of the interface between the filling material and the canal wall, radioisotope bacterial leakage, microscopic

analysis, Cone beam computed tomography (CBCT) and Micro- Computed Tomography (μ-CT).7,8,9

As we all know Radiovisiography (RVG) is an important and most available tool to access the quality of root canal space obturation. With paralleling technique and mesial distal angulation (SLOB/ MBD) techniques one can easily evaluate the presence of voids and adaptability of gutta percha in root canal space. Computed Tomography currently considered as the leading diagnostic tools for endodontic research. Thus CBCT has been successfully utilized in endodontics for the three dimensional reconstruction of the affected teeth.10

So aim of this in vitro study is to evaluate the voids and homogeneity of obturation ofthe root canals obturated by using two different obturation techniques namely the lateral compaction technique, and single cone obturation.

MATERIALS & METHOD COLLECTION OF SAMPLES

60 maxillary and mandibular first premolars which were freshly extracted for orthodontic purpose were collected and used for this study.

Exclusion Criteria: Teeth which had caries, restoration, apical resorption or had undergone previous endodontic treatment were excluded from this study. In order to standardize the samples for homogeneity, teeth which had acute curvatures, root canal anomalies and calcifications were excluded.

Preparation of the Samples

All the specimens were washed in running tap water for two minutes and were then immersed in 5.25% sodium hypochlorite solution for a period of 24 hours in order to remove the organic debris.

In Group1, Root canals were prepared using ISO size 15-30 No. K-Files with step back technique. All the standard protocols followed till the completion of cleaning & shaping of all the samples.

In Group II, Root canals were prepared using ISO size 15-20 no K-File with Step- Back technique. After thorough irrigation with 5.25% sodium hypochlorite (Prime Dental products Pvt Ltd, Mumbai, India) Canals were prepared using Protaper Gold Rotary File System (Dentsply, Maillefer, Ballaigues, Switzerland) upto size F3 with Step Down Technique. All the standard protocols followed till the completion of cleaning & shaping of all the samples.

Group 1 - Cold Lateral condensation

The 30 samples in group I were obturated using Lateral Compaction technique. This technique was done using a 30 size (0.02 taper) gutta percha (Dentsply, Maillefer, Ballaigues, Switzerland) as the master cone. The master cone was placed into the canal till the working length with tug back. Then 25, 20 and 15 sized finger spreaders (Dentsply, Maillefer, Ballaigues, Switzerland) were used to create spaces for Lateral Compaction of guttapercha and the root canal was filled with the appropriately sized accessory cones. The excess gutta percha at the orifice of the root canal was sheared off by using Buchanan plugger.

Group 2 – Single cone obturation

Another 30 samples in group 2 were obturated using single cone obturation technique as recommended by manufacturers instructions till Protaper-F3 gutta parcha. After satisfactory coating of canals with sealers, the greater taper gutta percha points were inserted and vertically compacted with the help of hand pluggers.

After obturation, all the access cavities were filled with Cavitemp and then stored at 37ºC and at 95% humidity for about 72 hours to aid in the complete setting of the sealers.

First RVG radiographs were done in order to evaluate the homogenous obturations. This was followed by CBCT scans in order to determine the volume of the obturated material at the coronal, middle and apical third of the obturated root canals. Approximately 15mm of the root length was taken into consideration for the CBCT analysis. This length of 15 mm was further divided into equal coronal, middle and apical segments. To detect the presence or absence of space or voids each segment was cut in slice thickness of 0.5 mm. and each tooth was then scanned for a section of 30 slices.

The volume of the root canal in each slice was calculated by multiplying the root canal area by the slice thickness (0.5mm) during the CBCT analysis (R). Thus the total volume of the predetermined (15mm) root length was calculated by adding up the values obtained for the total 30 slices. In the study specimens where void was seen, the inner area of the void was calculated using the linear measurements obtained using the Vatech pax-I 3D software and this value was multiplied by the slice thickness in order to calculate the Volume of the Void (V).The volume of the obturated material was calculated using the formula (R-V).

The Volume Percentage of the voids in the filled root canal was calculated by using the formula, (R-V) ×100/R where, R is the volume of the root canal space and V is the volume of the void space. The homogeneity of obturation was evaluated by estimating the number of the spaces or voids at different level of coronal, middle and apical segments of the obturated root canals.

Statistical Analysis

Descriptive data are presented as Mean±SD. One-way ANOVA was used for multiple group comparisons followed by Post Hoc Tukey's HSD Test for differences among mean. Level of significance was <0.05.

RESULT

The present in vitro study was designed to evaluate the qualityof two different obturation techniques; single cone and lateral condensation. The total volume percentage of obturation was recorded using CBCT scanner for both the techniques.

Table 1-: An Intergroup Comparison of Mean Total Volume Percentage (TVP) andstandard deviation values of obturation techniques

TVP (Total volumepercentage)		Groups	
		Lateral Compaction	Single Cone
Coronal	Mean	82.2557	77.3175
	SD	±6.56	±9.89
Middle	Mean	92.3896	83.5354
	SD	±8.48	±8.27
Apical	Mean	91.4842	87.0111
	SD	±6.68	±8.79

The lateral compaction method is considered as better due to higher total volume percentage(82.25±6.56 at coronal third, 92.38±8.48 at middle third and 91.48±6.68at apical third) ascompared to single cone obturation total volume percentage (77.31±9.89 atcoronal third, 83.53±8.27 at middle third and 87.01±8.79 at apical third)

Table-2: An Intragroup comparison of Mean Total Volume Percentage (TVP) usingunpaired t test

Coronal TVP	Mean	Unpaired t test		Unpaired t test	
		t value	p value	Lateral Compaction	Single Cone
Lateral Compaction	**82.2557**	459.26	<.0001	<.0001	<.0001
Single Cone	**77.3175**			—	<.0001
Middle TVP				**Lateral Compaction**	**Single Cone**
Lateral Compaction	**92.3896**	2944.6	<.0001	<.0001	<.0001
Single Cone	**83.5354**			—	<.0001
Apical TVP				**Lateral Compaction**	**Single Cone**
Lateral Compaction	**91.4842**	2375.6	<.0001	<.0001	<.0001
Single Cone	**87.0111**			—	<.0001

Lateral Compaction and single cone obturation technique showed statistically significant results.

Table 3: An Intergroup comparison of Mean Total Volume Percentage (TVP) usingone way ANOVA and pair wise comparison using post Hoc Tukey's HSD test

Lateral Compaction	Mean	ANOVA		Post Hoc Tukey HSD		
		F value	p value	Coronal	Middle	Apical
Coronal	**82.2557**	459.259	<.0001	<.0001	<.0001	<.0001
Middle	**92.3896**			—	<.0001	<.0001
Apical	**91.4842**			—	—	<.0001
Single Cone				**Coronal**	**Middle**	**Apical**
Coronal	**77.3175**	2741.9	<.0001	<.0001	<.0001	<.0001
Middle	**83.5354**			—	<.0001	<.0001
Apical	**87.0111**			—	—	<.0001

Among lateral compaction and single cone obturation, coronal, apical and middle area showed statistically significant results.

DISCUSSION

Enodontic treatment failures mainly occur due to the inadequate obturation of the root canal space. Hence, the quality of the obturation determines the long term success of the endodontically treated tooth.

In this study cleaning and shaping was performed by step back technique (group 1) using conventional K-files 15 – 30 size, and samples of group II were prepared with crown downtechnique using the protaper gold rotary system as per manufacturer's instructions.

During and after instrumentation, the irrigants facilitate the removal of the microorganisms, tissue remnants and dentin chips from the root canal space through a flushing mechanism. Irrigants also prevents the packing of the hard and soft tissues in the apical root canal and also the extrusion of infected material into the periapical area. The most widely used endodontic irrigant is 0.5% to 6.0% sodium hypochlorite (NaOCl). It hasa strong bactericidal activity and it also aids in dissolving vital and necrotic organic tissues.[11,12]

Smear layer can serve as an avenue for the ingress of microorganisms and also it can act asa source for the growth and activity of viable bacteria, which remain entrapped in the dentinal tubules.[13] Hence, in order to remove the smear layer, the root canals were irrigatedwith 5.25% sodium hypochlorite and 17% EDTA solution intermittently in this study.

In the present study, Sealapex was used primarily as a root canal sealer to produce rigidandstrong cross-linked polymer with dentin collagens.[14]

A preoperative CBCT analysis was done to evaluate the volume of the entire root canal space of all the study samples. CBCT is used as the diagnostic tool in this study because it is a non-invasive diagnostic method in which the entire root canal space can be evaluated in a single scan. CBCT is the best way to observe the homogeneity of the endodontic obturation.[15, 16, 17]

Both the obturation techniques, were evaluated for the homogeneity and the quality of the obturation using CBCT. Homogeneity means that the root canal filling is a well compacted, uniform mass, without the presence of voids. The obtained results (Table 3) demonstrated that in the inter group comparison for the presence of voids it was seen that the Lateral Condensation technique had significantly lesser number of voids (459.259) as compared to single cone obturation technique (2741.9) with significant p value <.0001.

(Table 3). Mean TVP in the coronal, middle and apical segment for both the techniques were statistically significant with the p value of <.0001.

The incidence of voids within root fillings may be affected by many factors such as the anatomical configuration of the canal system, the quality of canal preparation, the consistency and volume of sealer, the operator's expertise, and the technique used.[18]

The Cold Lateral Condensation technique showed a significantly higher percentage of volume filled when compared with the Single cone obturation technique. This could be dueto a mismatch in the shape of the master cone and the anatomy of the root canal.[19] Thus, achieving the fluid-tight seal in this technique is dependent on the usage of a sufficient amount of sealant. Poor adaptation of the single cone at the middle and coronal thirds ofthe root canal is another disadvantage due to the shape mismatch.[19]

In our study, the apical section of single cone obturation showed a lesser area of voids when compared to middle and coronal sections. This could be due to the close andmaximal fit of the gutta percha master cone apically more than coronal.

A Kumar and ARV Pai et al concluded that a greater taper of the master cone with close fitcan generate more hydraulic forces while seating it and further increase the flow of sealer apically by means of shear thinning mechanism. This may probably cause compression or collapse of air entrapped bubbles under pressure, and/or filling of voids by the enhanced flow of the sealer and could result in a lack of or lesser voids in the apical sections.[20]

These results are supported by Obeid et al, who concluded that single cone obturation had a good density in the apical portion when compared to the coronal portion of the canal.[21]

In intra group (Lateral compaction) mean total volume percentage (TVP) was higher in middle of the root canal space followed by apical and coronal (Table 2). In Lateralcompaction group, it may be

explained because root canals tend toward a rounder cross section at the apical segment (Wu et al. 2002), favouring the adaptation of the master cone, limiting the spreader penetration and, consequently, preventing accessory cones being inserted up to the working length.[22]

In the present study, although none of the obturation techniques were able to get 100% homogeneity, the lateral compaction method exhibited best due to higher total volume percentage (82.25±6.56 at coronal third, 92.38±8.48 at middle third and 91.48±6.68 at apical third) as compared to single cone obturation total volume percentage (77.31±9.89 at coronal third, 83.53±8.27 at middle third and 87.01±8.79 at apical third) (Table 1).

CONCLUSION

Within the limitations of this study, it can be concluded that voids were present in all the groups. in the inter group comparison it was seen that the Lateral Condensationtechnique had a lesser number of voids as compared to single cone obturation technique with statistically significant p value <.0001. In intra group (Lateral compaction) mean total volume percentage (TVP) was higher in middle of the root canal space followed by apical and coronal with statistically significant p value <.0001 for all segments.The lateral condensation group had the maximum overall volume percentage of the obturated material. Lateral condensation showed better homogeneity and quality of obturation followed by single cone obturation.

Therefore, further studies are necessary to evaluate the prognosis of the treatments performed with this technique, mainly in root canals presenting complex anatomy.

BIBLIOGRAPHY

1. Feiglin B. The pulp. A big issue about a little tissue. Aust Dent J. 1978;23(1):81- 86.
2. Muliyar S. Microleakage in endodontics. J Int Oral Health. 2014; 6(6): 99– 104.
3. Kiranmurthy D, Sujith R. Coronal Microleakage in Endodontically Treated Teeth filled with temporary Filling Materials – A Comparative study. Int J Consev Dent 2012;3(1):49–53.
4. Brayton S.M, Davis SR, Goldman M. Gutta-percha root canal fillings. An in vitroanalysis.Oral Surg Oral Med Oral Pathol 1973;35:226-31.
5. Adina SS, Iliescu A, Cistiana A, Simina D. A Comparative study of root canal fillings based on warm gutta percha condensation techniques. Int J Med Dent 2010; 2(2):102-106.
6. Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature -- Part 2. Influence of clinical factors. Int Endod J. 2008;41(1):316–318.
7. Shantiaee Y, Maziar F, Dianat O, Mahjour F. Comparing microleakage in root canals obturated with nano silver coated gutta-percha to standard gutta-percha by two different methods. Iran Endod J. 2011; 6(4):140–45.
8. Vasiliadis L, Kodonas K, Economides N, Gogos C, Stavrianos C. Short and long term sealing ability of Guttaflow and AH-Plus using an ex vivo fluid transport model. Int Endod J2010; 43:377-381.
9. El Sayed MA, Taleb AA, Balbahaith MS. Sealing ability of three single-cone obturationsystems: An in-vitro glucose leakage study. J Conserv Dent. 2013;16(6):489-93.
10. Zang R, Wang H, Tian YY, Hu T, Dummer MH. Use of cone beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese
11. individuals. Int Endod J 2011; 44: 990-99.
12. Carson KR, Goodell GG, McClanahan SB. Comparison of the antimicrobial activity of six irrigants on primary endodontic pathogens. J Endod. 2005;31(6):471-3.
13. Clegg MS, Vertucci FJ, Walker C, Belanger M, Britto LR. The effect of exposure to irrigant solutions on apical dentin biofilms in vitro. J Endod. 2006;32(5):434-7.
14. Sharma G, Kakkar P, Vats A. A comparative SEM investigation of smear layer remaining on dentinal walls by three rotary NiTi files with different cross sectional designsin moderately curved canals. J Clin Diag Resear 2015;9(3):43-46.
15. Wolf M, Küpper K, Reimann S, Bourauel C, Frentzen M. 3D analyses of interface voidsin root canals filled with different sealer materials in combination with warm gutta-percha technique. Clin Oral Investig. 2014;18(1):155-61.

16. Gupta R, Dhingra A, Panwar N. Comparative evaluation of three different obturating techniques lateral compaction, thermafil and calamus for filling area and voids using cone beam computed tomography: An invitro study. J Clinic Diag Resear 2015; 9(8):15–17.
17. Huybrechts B, Bud M, Bergmans L, Lambrechts P, Jacobs R. Void detection in root fillings using intraoral analogue, intraoral digital and cone beam CT images. Int Endod J. 2009;42:675- 85.
18. Scarfe WC. Cone beam computed tomography: A paradigm shift for clinical dentistry. Aus Dent Pract 2007:102-110.
19. Inan U, Aydin C, Tunca YM, Basak F. In vitro evaluation of matched-taper single-cone obturation with a fluid filtration method. J Can Dent Assoc. 2009;75(2):123.0
20. Sawhney T, Abraham AA, Mahabala KY, Sen M, Natarajan S, Thilak N, Rao A, Nayak
21. Comparative evaluation of porosity distribution in root canals obturated with gutta-percha using single-cone technique and thermoplasticized technique. Saudi Endod J 2020;10:126- 30.
22. Kumari A, Pai V. Comparative assessment of the area of sealer voids in single cone obturation done with mineral trioxide aggregate, epoxy resin, and zinc-oxide eugenol based sealers Saudi Endodontic Journal 2016;6(2):61.
23. Obeidat RS, Abdallah H. Radiographic evaluation of the quality of root canal obturationof single-matched cone Gutta-percha root canal filling versus hot lateral technique. Saudi Endod J 2014;4:58-63.
24. Wu M-K, Bud MG, Wesselink PR. The quality of single cone and laterally compacted gutta- percha fillings in small and curved root canals as evidenced by bidirectional radiographs and fluid transport measurements. Oral Surg Oral Med Oral Pathol Oral Radiol Endod.2009;108(6):946-51.