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A Comparative Evaluation of 3-Dimensional Obturation using Three Different Techniques Namely: Lateral Condensation, Warm Vertical Compaction using Beefill and Thermomechanical Compaction for Unfilled Areas and Voids using CBCT. An In Vivo Study.

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Abstract

***Introduction**: The rationale for endodontic treatment is to eradicate the infection, prevent microorganisms from infecting or re-infecting the root and/or periradicular tissues. A 3-dimensional seal of root canal is essential for successful endodontic therapy.*

***Aim:** To evaluate and compare in vivo three different obturating techniques namely: lateral condensation, warm vertical compaction with Beefill and thermomechanical compaction, for unfilled areas and voids using CBCT.*

***Materials and Method:** A total of forty-five single rooted teeth of patients requiring root canal treatment as well as dental implant were considered so as to prevent unnecessary radiation exposure through CBCT. Root canals were performed by step-back technique using K-files and obturations were done using AH plus sealer. Fifteen teeth per each group i.e. Lateral Condensation, Warm Vertical Compaction using BeeFill and thermo mechanical compaction, were divided. The quality of obturation was assessed through CBCT at saggital and axial sections, and voids and unfilled areas were calculated by Image J software. The data was statistically analysed using SPSS version 23.*

***Results:** The maximum number of voids was observed in canals obturated with thermo mechanical compaction followed by lateral condensation. Warm vertical compaction with BeeFill showed lesser number of voids and more of the obturating material when compared to other techniques.*

***Conclusion:** Within the limitations of this study it can be concluded that Warm Vertical Obturation with BeeFill can be considered as a good obturating technique.*

***Keywords:** Obturation, Hermetic seal, CBCT, Lateral condensation, Voids.*

Introduction

Complete obturation of the root canal system is the main goal of endodontic therapy, and nearly 60% of all endodontic failures have been attributed to incomplete obturation of the root canal system.{1} A three dimensional seal of the root canal system is achieved by proper root canal obturation to prevent the recurrence of bacterial infection. Obturation of the root canal must be hermetic to ensure eradication of microorganisms and prevent their re-growth to avoid subsequent periapical diseases. {2}

A meta-analysis of factors influencing the efficacy of primary root canal treatment found that the following four factors influenced success: the absence of pre treatment periapical lesion, root canal fillings with no voids, obturation with in 2.0mm of the apex, and an adequate coronal restoration. {3}

In order to achieve the perfect obturation, many materials have been tested like Silver points, Gutta-Percha and Resilon and many obturating techniques including lateral condensation, thermo compactors and vertical compaction has evolved. Over the years, pitfalls with one technique have often led to the development of newer methods of obturation mainly in the in vitro studies.

Lateral compaction of GP is the gold standard technique. This technique has remained a standard in studies focusing on comparison of obturation techniques.{4} The McSpadden technique of obturating root canals with thermoplasticized gutta-percha has been used for several years.{5} BeeFill 2in1 (VDW, Munich, Germany) is a recently introduced warm vertical obturation system that includes downpack and backfilling equipment in one unit. Despite commercial claims with regard to its efficacy in providing a tightly sealed root canal filling, scientific data on the sealing properties of BeeFill 2in1 are still lacking. {6}

There are many in vitro studies in the literature which have compared different obturating techniques with one another. However few in vivo studies exist which compare the efficiency of different obturating techniques. With the development of technologies such as cone beam computed tomography, it is now possible to compare quality of obturation of different obturating techniques. So, a study is proposed to compare and evaluate, in vivo, three different obturating techniques namely, lateral compaction, thermomechanical and BeeFill for any voids and unfilled areas using cone beam computed tomography.

Materials and Methods

This is original research conducted in the Department of Conservative Dentistry and Endodontics, Al Badar Dental College and Hospital, Gulbarga, Karnataka. In this study forty-five single rooted teeth of patients requiring root canal treatment adjacent to edentulous space for implant requiring CBCT were taken, so as to prevent patients from unnecessary exposure to radiation from CBCT.

Teeth were radiographically examined for straight, single canals and closed apices. Teeth with curved, multiple canals and open apices were excluded from the study. Ethical clearance was obtained from the Institutional Ethical Review Board (IERB).

Access was prepared and the root canals were subjected to chemo-mechanical preparation with the step-back technique using K-files (DENTSPLY). The master apical file was standardized to three times the size of the initial apical file and 3% NaOCl, 17% EDTA, Normal Saline was used as an irrigant after each instrument. Recapitulation with smaller size files was done during chemo-mechanical preparation and canals were dried using paper points (DENTSPLY). Teeth of the patients were divided into three groups of fifteen teeth per each group and obturation using AH plus sealer (DENTSPLY) was carried out:

Group 1:

Lateral Condensation:

A standardized gutta-percha master point was selected and introduced into the root canal to full working length and was checked for tug-back criteria. AH plus sealer was applied to the canal wall using lentulo spirals. The master gutta-percha point was then coated with a sealer and introduced slowly into the root canal until the working length is reached. Lateral condensation was performed using standardized finger spreaders and accessory gutta-percha points. The excess coronal gutta-percha was removed by a heated instrument.

Group 2:

Warm Vertical Compaction with BeeFill Technique:

The master gutta-percha cone was placed 0.5mm to 1mm short of the working length and was checked for tug-back. The canal walls were coated with AH plus sealer. The master GP point was placed into

the canal 0.5mm short of working length and the BeeFill heat carrier preset to 180°C was used to cut the gutta-percha from the middle third. The softened GP was condensed with the help of pluggers, the apical fill was assessed by a radiograph and the remaining canal was filled with BeeFill backfill system.

Group 3:

Thermo Mechanical Compaction:

Obturation using the RevoCondensor (MICRO-MEGA) with AH Plus sealer was done. The master GP cone was fitted at 0.5mm short of working length and checked for tug-back. The canals were coated with AHplus sealer and the RevoCondensor was used as per manufacturer's instructions. RevoCondensor was placed into the root canal and the hand piece was rotated at 10,000-15,000 rpm and slightly pressed against the master cone until its plastification. Slowly RevoCondensor was pulled out of the root canal using a slight up and down movement and performing light pressure on a canal wall. The excess GP was eliminated from the pulp chamber with the heated part of a plugger for vertical condensation. The remaining GP was condensed with the flat and cold part of the plugger.

Assessment of quality of above mentioned obturation's was done by calculating the unfilled area and voids in each tooth at sagittal and axial plane by cone beam computed tomography using ImageJ imaging software. [FIGURE 1]

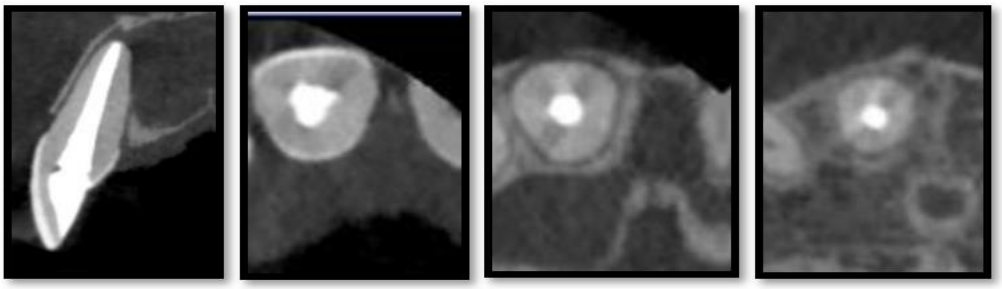


Fig 1: CBCT Images at Saggital, Coronal, Middle And Apical Section

Results

Assessment of quality of obturation's was done by calculating the unfilled area and voids in each tooth at saggital and axial plane by cone beam computed tomography using ImageJ software.

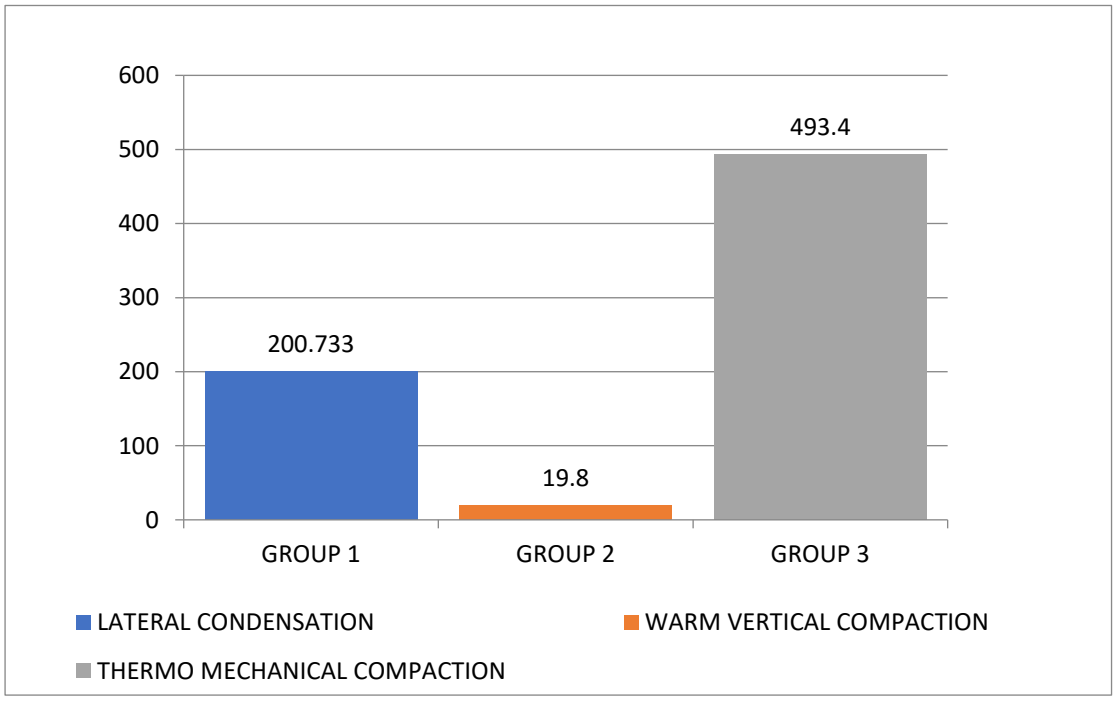
- Data was analyzed using SPSS Version 23.

Statistically significant difference was present between the various groups in number of voids at saggital position [Table 1]. Group 2 showed lesser number of voids. Group 1 has more number of voids when compared to Group 2 and less when compared to Group 3 [Graph 1].

There is statistically significant difference present between the various locations at axial sections in different groups for number of voids [Table 2]. The mean number of voids at coronal location in Group 2 was less than Group 3 and Group 1. Group 1 showed highest number of voids. The mean number of voids at middle location in Group 2 was less than Group 1 and Group 3. Group 3 showed highest number of voids. The mean number of voids at apical location in Group 2 was less than Group1 and Group 3. Group 3 showed highest number of voids [Graph 2].

Group	Mean	SD
Group 1	200.73	72.89
Group 2	19.80	4.31
Group 3	493.40	216.30

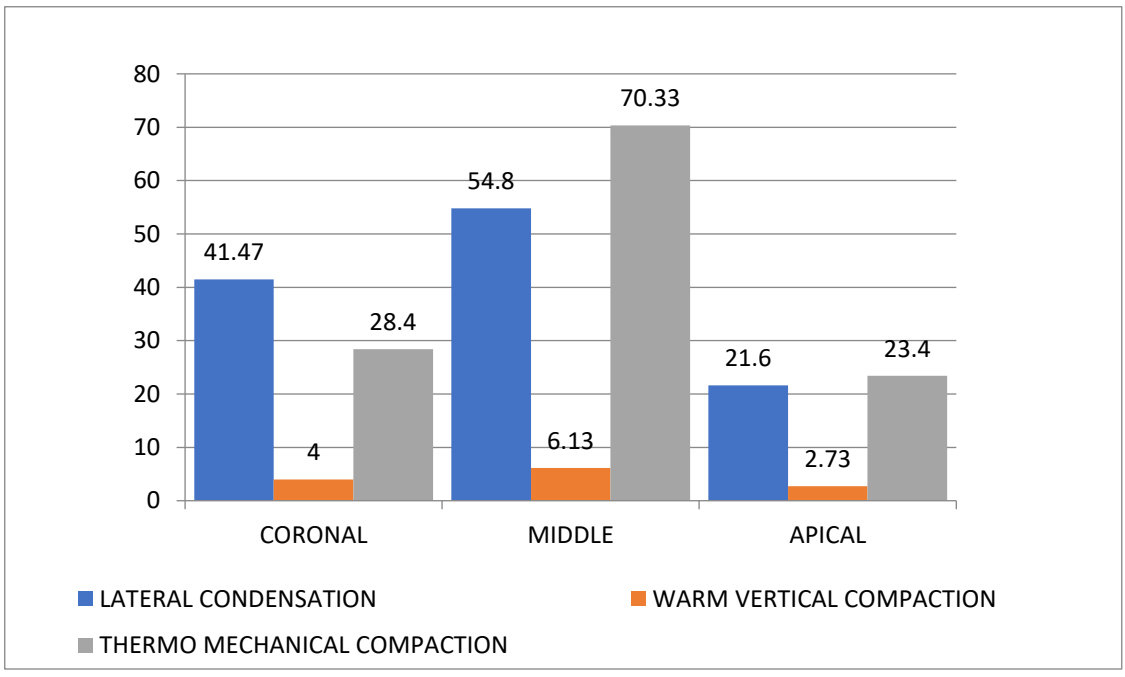
Table 1: Mean and SD of NO Of Voids in Sagittal Sections in Various Groups



Graph 1: The Mean Number of Voids at Sagittal Position

Location	N	Group 1	SD	Group 2	SD	Group 3	SD
Coronal	15	41.47	16.33	4.00	1.85	28.40	4.48
Middle	15	54.80	21.05	6.13	3.98	70.33	18.16
Apical	15	21.60	10.97	2.73	1.28	23.40	4.19

Table 2: Mean No of Voids in Various Locations



Graph 2: The Mean Number of Voids in Various Groups

All the three groups showed voids and unfilled areas, but Group 2 i.e., Warm Vertical Compaction with BeeFill showed lesser voids and satisfactory adaptation to the canal walls.

Discussion

The aim of root canal filling is to obtain an effective sea¬ling of the root canal system both coronal and apical and it is a very challenging step in endodontic treatment. Several clinical studies representing various techniques report, the success rate of endodontic therapy ranges from 87.4% to 94.5%. The most common cause of endodontic failure has been ascribed to incomplete obturation. {1}

Gutta–percha (GP) is the most commonly used root canal obturation material. It is compressible, inert, dimensionally stable, tissue tolerant, radiopaque, and becomes plastic when heated. Its physical properties have made possible several obturation techniques.{7} AH-Plus, which is an epoxy resin root canal sealer, is found to be more adaptable.{8} Hence gutta-percha with AH-Plus sealer was used in this study for obturation.

Canals prepared with the step-back technique allowed greater penetration of the spreader, which resulted in less apical leakage. It has often been said that, when a canal is properly prepared, a variety of filling materials or techniques would probably be successful. {9}

CBCT was applied in this study because it provides insight into the details of 3D images of fillings, especially voids and defects, at a level that is impossible to achieve with other 2D conventional radiographic methods. Demiralp K O et al (2012) conducted an ex vivo study in which, assessment of endodontically treated teeth was done using CBCT and other radiographic methods. In this study, CBCT was found to be successful in the assessment of teeth with ideal root canal treatment and teeth with canals filled short of the apex. {10}

In the present study lateral condensation was used, because it is the most commonly used and studied technique, and therefore, it served as a standard with which other techniques could be compared.{2,4,6} In the present study, lateral condensation when compared with that of warm vertical condensation and thermo-mechanical compaction at saggital section showed a significant difference of 200.73 ±72.89, At axial sections the mean number of voids at coronal location was 41.46±16.32, at middle section was 54.80±21.04 and at the apical section it was 21.60±10.97 which was better than that of thermo mechanical compaction, but poor with warm vertical compaction technique.

Thermo-mechanical condensation or automated thermatic condensation was introduced by McSpadden in 1978. Since then this technique was used in many studies to evaluate the sealing ability.{5, 12} However in the present study obturation with thermo-mechanical compaction showed highest number of voids when compared to lateral condensation and warm vertical compaction. The mean number of voids at saggital position in thermo-mechanical technique was 493.40±216.30 which was much higher than that of lateral condensation. At axial sections the mean number of voids at coronal section was 28.4±4.48 at middle was 70.33±18.16 and at apical section it was 23.4±4.18. Thermo-mechanical compaction showed less number of voids in coronal section when compared to lateral condensation but showed highest number of voids in all the other sections.

Root canal obturation by the BeeFill system results in reliable obturation of lateral canals, minimal risk of root fracture, gutta-percha filling to the desired level for immediate placement of a fiber post, and adhesive restoration in 1 appointment.{11} Fewer studies {6, 11} has been conducted to evaluate the sealing efficacy of BeeFill and showed satisfactory results. Similarly in the present study, warm vertical compaction with BeeFill showed better results when compared to that of lateral condensation and thermo-mechanical compaction. The mean number of voids at saggital position was 19.80±4.31 which was excellent when compared to other techniques. In axial sections the mean number of voids at coronal level was 4±1.85, at middle level 6.13±3.97 and at the apical position it was 2.73±1.27 which was the lowest when compared to lateral condensation and thermo-mechanical compaction.

Conclusion

Within the limitations of this study, it can be concluded that:

1. Obturation with warm vertical compaction using BeeFill unit can produce a good 3-dimesional obturation, and it may be helpful in obtaining the good hermetic seal of endodontically treated teeth.

2. The use of CBCT must be considered for evaluating the voids and unfilled areas as it 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.

Further research is required in determining the amount of filling areas and voids in vivo by using CBCT in other obturation techniques.

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