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# Comparative volumetric analysis of conventional lateral compaction and two different thermo plasticized obturating techniques in single rooted permanent teeth

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***Background and Aim of the study:*** *Root canal treatment in mature teeth of children and adolescents is basically similar to that performed in adults. However due to their wide canals and thin dentin walls in comparison to that of adult patient, special precautions are needed in order to achieve three-dimensional seal during obturation. Since some persistent microorganisms may remain inside the root canal system even after instrumentation, a tight apical seal is desired in order to prevent the bacteria and their by-products from invading the root apex. In-depth appreciation regarding the importance of filling canals laterally and vertically along with the adaptation of clinical technique is significant in achieving three-dimensional filling of root canal space. Hence the present study aimed to compare volumetrically laterally condensed gutta-percha obturation with two different thermoplasticized obturation techniques namely – GuttaCore (Dentsply Maillefer) and Obtura III MAX (Obtura Spartan) by Spiral Computed Tomography.****Methodology****:Thirty-six (36) single rooted extracted permanent teeth were collected anddivided into three groups of twelve teeth each. Root canals were prepared with crown down techniques up to size F2. Specimens were scanned using Spiral CTandvolume of each canal was calculated.The samples in group 1 were obturated using the Lateral Compaction technique, in group 2 the samples were obturated using GuttaCore, the samples in group 3 were obturated with Obtura III Max.second spiral CT scan done and post obturation volume were calculated using syngo software similarly as post BMP volume.Percentage of obturated volume was calculated and compared between three groups.*
***Results****: Core-carrier obturation (GuttaCore) technique exhibited highest overall volume percentage of the obturated material followed by Obtura III MAX and Lateral condensation technique.*
***Conclusion:*** *GuttaCore and Obtura III MAX groups were found to be superior as compared to the conventional lateral compaction in order to achieve three dimensional obturation.*
***Keywords:*** *three dimensional obturation, Guttacore, Obtura III max, percentage of obturation.*

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## I. Introduction

One of the keys to achieve impermeable seal with an inert filling material for successful endodontic therapy is to establish complete three-dimensional obturation of a root canal space. Success of root canal treatment depends upon the triad of thorough canal debridement, effective disinfection and three dimensional obturation.[1] The objective of obturation is to fill the entire canal space and subsequently eliminate all possible portals of entry between canal and the periodontium.[1] Hence an ideal root canal filling is the one which three-dimensionally fills the entire root canal space as close to the cemento-dentinal junction as possible.[2]

In-depth appreciation regarding the importance of filling canals laterally and vertically along with the adaptation of clinical technique is significant in achieving three-dimensional filling of root canal space [2]. Obturation of the root canal space also helps to eliminate most of the avenues associated with leakage from the oral cavity and also from the periradicular tissues into the root canal system.[3] Since some persistent microorganisms may remain inside the root canal system even after instrumentation, a tight apical seal is desired in order to prevent the bacteria and their by-products from invading the root apex.[4]

The presence of micro-organisms, their toxins and metabolites results in the loss of vitality of the pulp and also leads to subsequent formation of periradicular infection. Inability to eliminate one or all of these

etiologic factors is one of the prime reasons for the failure of root canal therapy.[4] Several obturation techniques are now being practiced in the field of endodontics, among which the Cold Lateral Condensation technique still has been recommended for routine clinical use[11]

Studies have shown that plasticized gutta-percha can easily be moved into the canal irregularities, thus replicating the intricacies of the root canal system. There are a number of methods that make use of the plasticized gutta-percha. These include warm lateral condensation, warm vertical condensation, coated carrier system, injection systems and thermomechanicalcompaction.[12]The concept of carrier based thermoplasticized gutta-percha obturation method was introduced by Johnson in 1978. These products are marketed today as ThermaFil Plus (Tulsa dental products), GT & GTX Obturators (Tulsa Dental Product, Tulsa, OK, U.S.A), ProTaper obturators (Tulsa dental products), WaveOne obturators (Dentsply Maillefer, Ballaigues, Switzerland).[13]

The quality of the root fillings has been assessed through different experimental approaches such as the acid dissolution of roots, electro chemical method, fluid filtration, dye penetration, radiographs, sections of the sample, the SEM analysis of the interface between the filling material and the canal wall, radioisotope bacterial leakage, microscopic analysis. They provide semi-quantitative results showing a high level of variation.[16] It has been proven that spiral computed tomography (SCT) has been a successful tool in various in vivo and various laboratory studies. With the help of SCT three-dimensional volume measurements are possible without sectioning the specimens thus avoiding loss or destruction of the material.[16]

As new gutta-percha condensing techniques have been developed to minimize the sealer and maximize the gutta-percha content, the purpose of this study is to evaluate volumetrically the root canals that were filled with either Lateral condensation, Carrier based obturation technique (GuttaCore), injection-moldedthermoplasticized gutta-percha (Obtura III MAX)techniques.

## II. Materials And Methods:

Thirty-six (36) single rooted permanent teethwhich were extracted because of orthodontic purpose or compromised periodontal condition were collected. All the collected teeth specimens were then washed thoroughly 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 such as the tissue remnants which were adherent to the root surface. Any calculus, present on the surface of the root was removed using hand scaling instruments. The prepared samples were then stored in normal saline solution at 37ºC and at 95% humidity for a period of 15 days. The specimens were decoronated with a diamond disc to obtain a standardized tooth length of 15mm for all the samples. The occlusal surface of decoronated specimens were made flat as a reference point for working length. The external surface of root will be sealed with nail varnish to prevent extrusion of irrigants. Access opening of the teeth was made using airotor and round bur BR-45.A manual size 10 – Stainless Steel K-file was inserted into the canal until the tip of the file was visible at the apical foramen and 1mm was reduced to obtain the working length. Rotary Nickel-Titanium ProTaper Goldfiles were used to prepare the root canal with crown down techniques up to size F2, the apical patency was maintained during the procedure using a 10Stainless Steel K-file to the working length. 5.25% sodium hypochlorite and saline were used as irrigants between each file size. EthyleneDiamine Tetraacetic acid (EDTA) solution was used as a lubricant during instrumentation. Before filling, root canals were dried using appropriate paper points.

After the preoperative Spiral CT analysis, prepared samples were then grouped into three groups with twelve samples each. AH plus sealerwas mixed according to the manufacturer instructions and was coated along the walls of the prepared canals using a lentulospiral attached to a micromotor hand piece rotating at 300 rpm. The samples in group 1 were obturated using the Lateral Compaction technique, in group 2 the samples were obturated using GuttaCore, the samples in group 3 were obturated with Obtura III Max. All these procedures were carried out according to the manufacturer's instructions.

- **Group 1: -Conventional lateral condensation (CLC)** This technique was done using a 25 size (0.06 taper) gutta perchaas 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 were used to create spaces for Lateral Condensation of gutta-percha 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 a heated ball burnisher.
- **Group 2: - Core carrier technique (Guttacore)** Each canal was obturated with a size 25,0.06 taper GuttaCore obturator using the directions specified by manufacturer. The shape of canal space at working length and passive fit of the obturator were verified. A GuttaCore obturator was heated in the ThermaPrep 2 oventill 20 seconds while the canal is coated with a sealer. After the first signal "beep" of the Oven, the obturator is ready for use. The heated GuttaCore obturator was slowly inserted to working length in one continuous motion without twisting or forcing. The shaft and the handle of obturator was bent and removed. Excess of gutta-percha at the coronal level was removed with the help of round bur in a high-speed handpiece under copious water spray.

- **Group 3: - Obtura III MAX** The canals in group 3 was obturated using high temperature thermoplasticized injectable gutta-percha system Obtura III MAX. The temperature control on the unit was adjusted to $200^0$ C, and once the Obtura III MAX unit had reached the operating temperature, 23-gauge applicator silver needle was placed within middle 1/3 of canal 4 mm short of working length as per manufacturer instructions. The process of injecting the gutta-percha was initiated by steadily squeezing the trigger until the material flowed out the end of applicator needle and pushed needle 3 mm out of the canal from backpressure of gutta- percha, without exerting pressure exerted on the needle. Obtura III needle was removed and vertical condensation was done immediately with hand pluggers. After the apical plug had reached body temperature and solidified, process of backfilling was continued & subsequently compacted

After obturation, all teeth are then stored at 37ºC for about 72 hours to aid in the complete setting of the sealers. Then second Spiral CT scan was done in order to determine the volume of the obturation in each root canal. 15mm of the root length was taken into consideration for the analysis. Post obturation volume were calculated using syngo software similarly as post BMP volume from the coronal portion till apex, by identifying the voids within the obturated teeth samples which appears as a radiolucent shadow on spiral CT scan. Percentage of obturated volume was calculated as {(a-b) x100/a)}, where 'a' was volume of the root canals after biomechanical preparation and 'b' was volume of the root canals (voids) after obturation with the three different techniques.

The samples were divided randomly into three groups of twelve teeth each. Then the samples were numbered from 1 to 36 and mounted on silicon impression material in order to standardize the long axis of the tooth pre and post operatively for scanning under spiral CT scan. Specimens were scanned using Siemens Somatom Definition model of Spiral CT. They were then viewed under high resolution, both cross-sectionally and longitudinallywithaconstantthicknessof0.5mm/sliceandaconstantspiralortablespeedof0.5and140kvp,the scanned data were then transferred to Syngo (Siemens) image analysis software, the volume of each canal was calculated with the aid of syngo software from coronal portion till apex.

**STATISTICAL ANALYSIS:** Data was analysed using Statistical Package for Social Science (SPSS) Version 19 statistical software. Data was presented as minimum to maximum range, mean, standard deviation. Comparison of mean in between multiple groups was done using one-way Analysis of Variance test (ANOVA). Pairwise comparison in between the groups was done using Tukey HSD post Hoc test. Subset grouping was done of the means of compared groups. Significance was set at 95%, $p<0.05$ was considered statistically significant.

## III. Results:

There was statistically very high significant ($p<0.001$) difference of Percentage of obturated volume in between the three groups. Highest percentage of obturated volume (POV) was found in group 2(GuttaCore) followed by group 3(Obtura III MAX) and least percentage was recorded in group 1(Lateral condensation).

Means of percentage of obturation volume in three group were statistically different, mean percentage of obturated volume of Group 2(GuttaCore) > Group 3(Obtura III MAX) >Group 1(Lateral condensation)

**TABLES**

**Table 1: Comparison of Post bmp volume (cc) of root canals of three different groups.**

| | N | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Group 1 | 12 | 0.0275 | 0.0028 | .0214 | .0310 |
| Group 2 | 12 | 0.0298 | 0.0034 | .0247 | .0364 |
| Group 3 | 12 | 0.0275 | 0.0022 | .0236 | .0305 |

**ANOVA**:

| | Sum of Squares | df | Mean Square | F | p value |
|---|---|---|---|---|---|
| Between Groups | 4.3286E-05 | 2 | 2.1646E-05 | 2.932 | .067 |

**Table 2: Pairwise Comparison of Post bmp volume (cc) in between three groups.**

| (I) GROUP | (J) GROUP | Mean Difference (I-J) | p value |
|---|---|---|---|
| 1 | 2 | -0.0023 | .098 |
| 1 | 3 | -0.00001 | .997 |
| 2 | 3 | 0.0023 | .114 |

**Table 3: Comparison of Void space volume (cc) of root canals obturated with three different obturation techniques.**

| | N | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Group 1 | 12 | 0.0030 | 0.0003 | .0025 | .0035 |
| Group 2 | 12 | 0.0010 | 0.0002 | .0006 | .0012 |
| Group 3 | 12 | 0.0020 | 0.0003 | .0013 | .0024 |

**ANOVA:**

| | Sum of Squares | df | Mean Square | F | p value |
|---|---|---|---|---|---|
| Between Groups | 2.44038E-05 | 2 | 1.22019E-06 | 162.857 | <0.001 |

**Table 4: Pairwise Comparison of Void space volume (cc) in between three different obturation techniques.**

| (I)GROUP | (J)GROUP | Mean Difference (I-J) | p value |
|---|---|---|---|
| 1 | 2 | 0.0020 | <0.001 |
| 1 | 3 | 0.0010 | <0.001 |
| 2 | 3 | -0.0010 | <0.001 |

**Table 5: Comparison of post obturation volume (cc) of root canals obturated with three different obturation techniques.**

| | N | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Group 1 | 12 | 0.0244 | 0.0027 | .0187 | .0280 |
| Group 2 | 12 | 0.0288 | 0.0032 | .0235 | .0353 |
| Group 3 | 12 | 0.0255 | 0.0022 | .0215 | .0256 |

**ANOVA:**

| | Sum of Squares | Df | Mean Square | F | p value |
|---|---|---|---|---|---|
| Between Groups | 1.2526E-04 | 2 | 6.2628E-05 | 8.505 | .001 |

**Table 6: Pairwise Comparison of post obturation volume (cc) between three different obturation techniques.**

| (I) GROUP | (J) GROUP | Mean Difference (I-J) | p value |
|---|---|---|---|
| 1 | 2 | -0.0044 | 0.001 |
| 1 | 3 | -0.0011 | 0.006 |
| 2 | 3 | 0.0033 | 0.001 |

**Table 7: Comparison of percentage of obturated volume of root canals with three different obturation techniques.**

| | N | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Group 1 | 12 | 88.88 | 1.36 | 87.31 | 91.23 |
| Group 2 | 12 | 96.55 | 0.71 | 95.14 | 98.13 |
| Group 3 | 12 | 92.53 | 1.32 | 90.16 | 95.37 |

**ANOVA:**

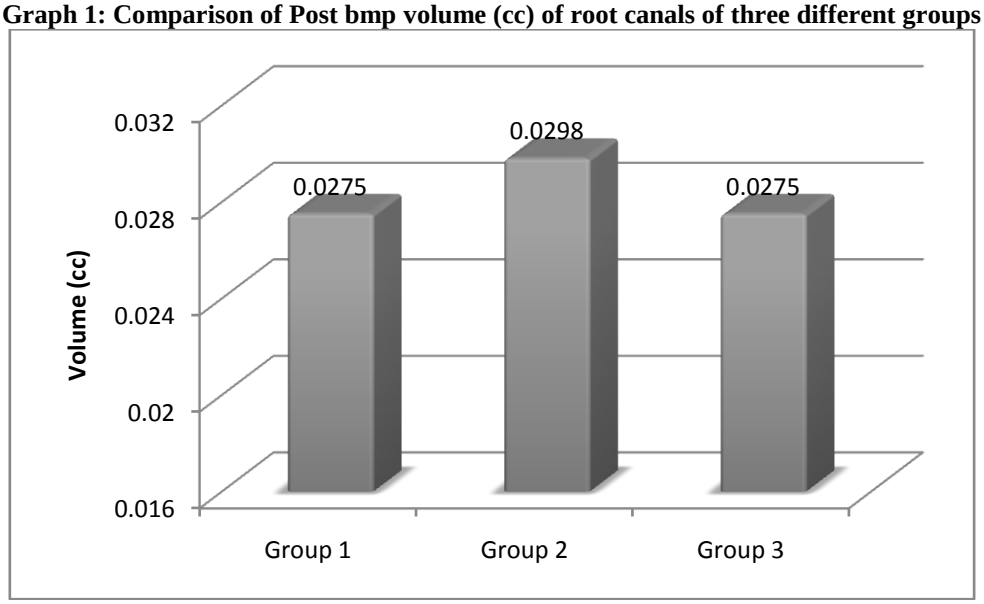
| | Sum of Squares | Df | Mean Square | F | p value |
|---|---|---|---|---|---|
| Between Groups | 353.047 | 2 | 176.523 | 128.27 | <0.001 |
| Within Groups | 45.41 | 33 | 1.376 | | |
| Total | 398.460 | 35 | | | |

**Table 8: Pairwise Comparison of percentage of obturated volume in between three different obturation techniques.**

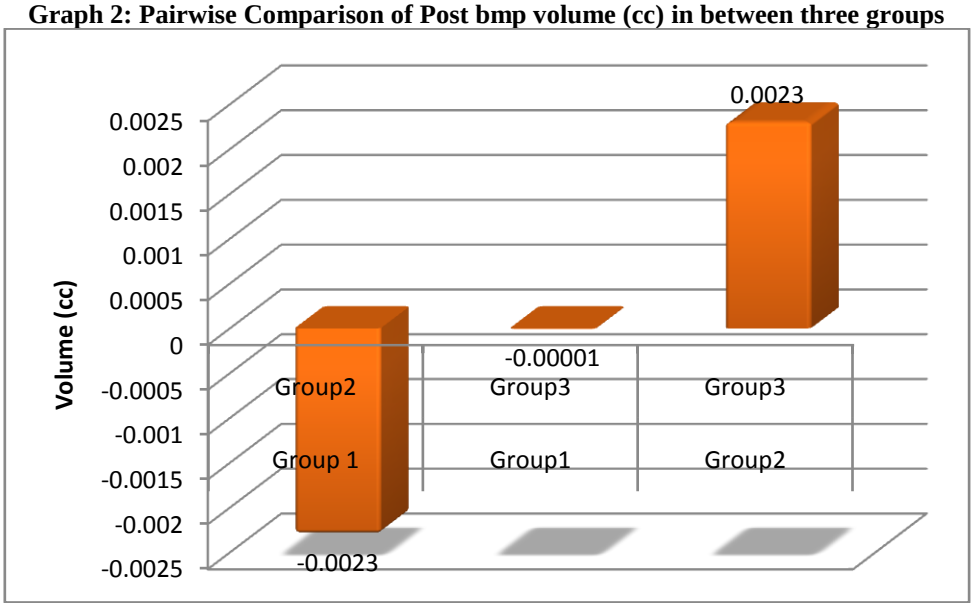
| (I) GROUP | (J) GROUP | Mean Difference (I-J) | p value |
|---|---|---|---|
| 1 | 2 | -7.67 | <0.001 |
| 1 | 3 | -3.65 | <0.001 |
| 2 | 3 | 4.01 | <0.001 |

**GRAPHS**

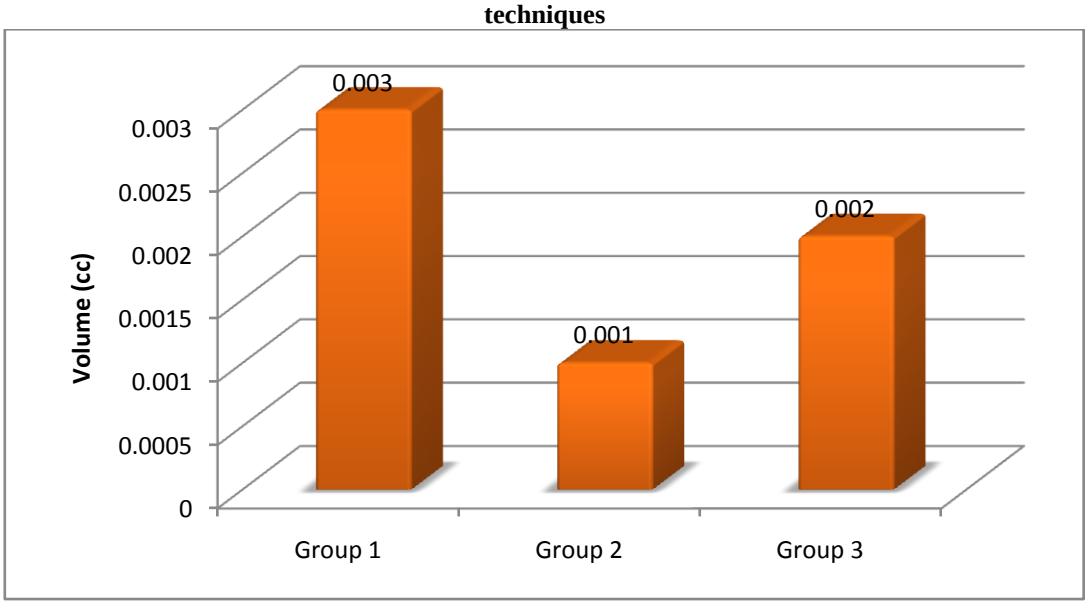
**Graph 1: Comparison of Post bmp volume (cc) of root canals of three different groups**



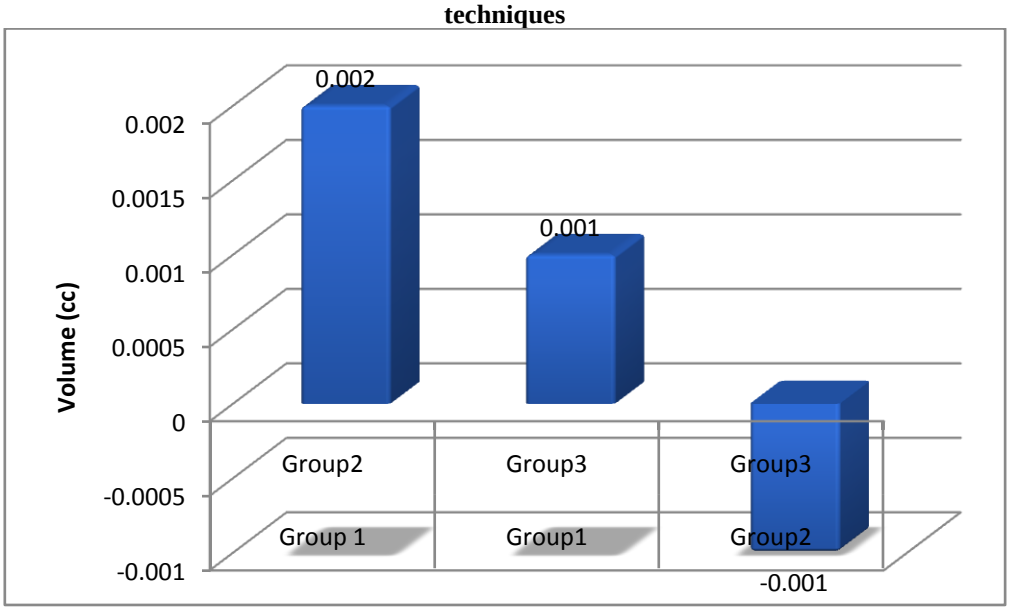

**Graph 2: Pairwise Comparison of Post bmp volume (cc) in between three groups**



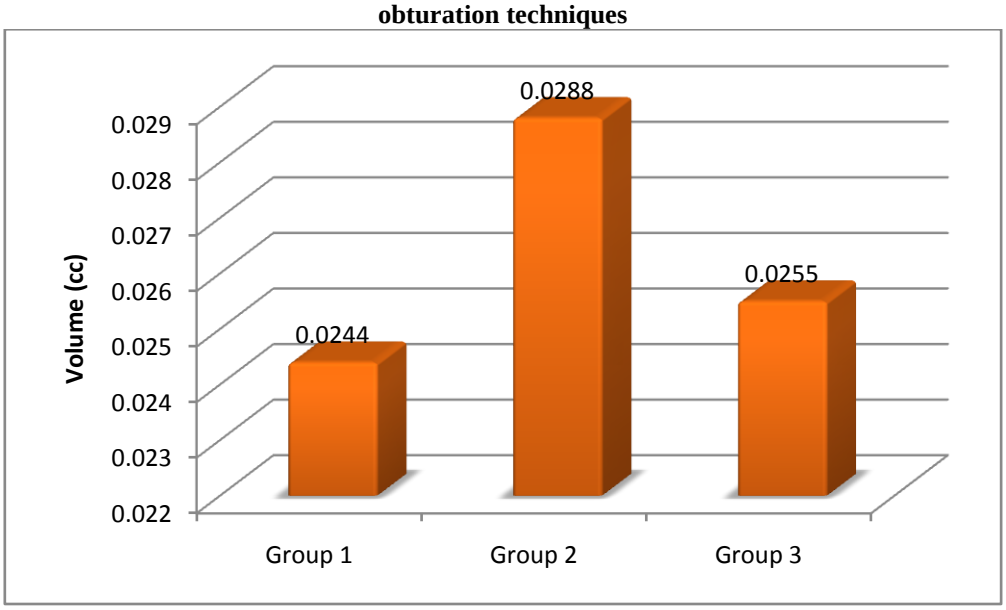
**Graph 3: Comparison of Void space volume (cc) of root canals obturated with three different obturation techniques**



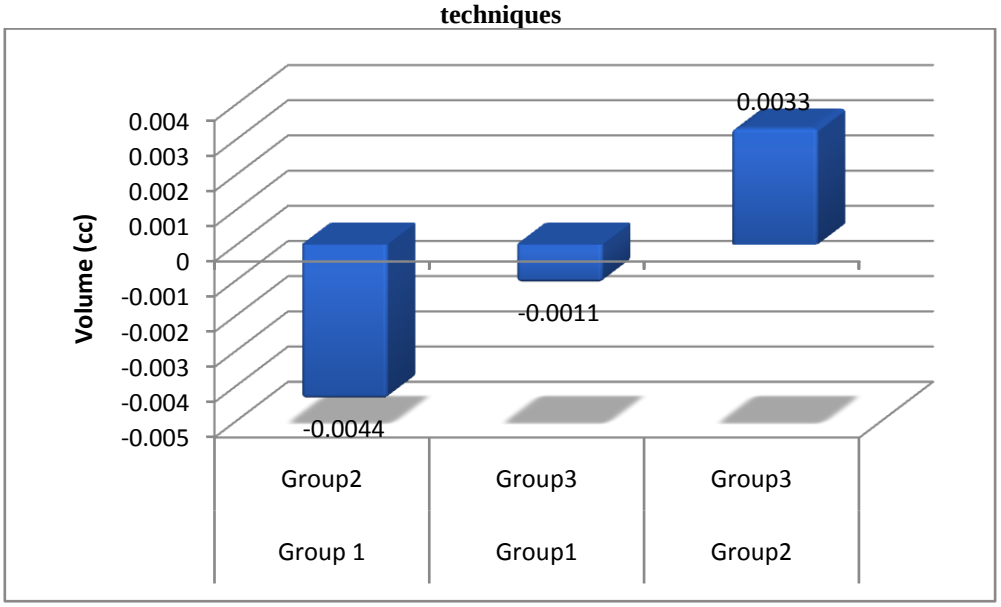

**Graph 4: Pairwise Comparison of Void space volume (cc) in between three different obturation techniques**



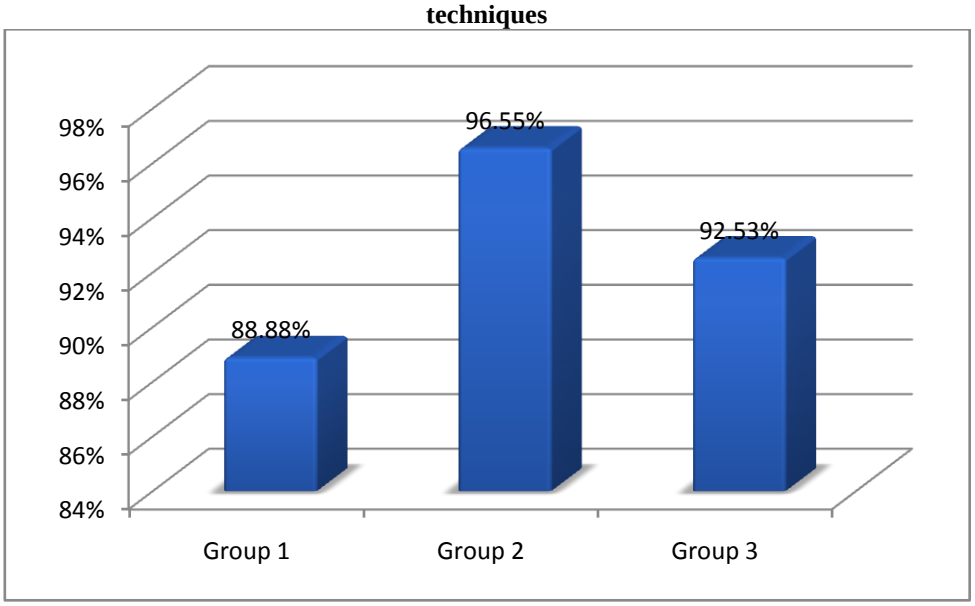
**Graph 5: Comparison of post obturation volume (cc) of root canals obturated with three different obturation techniques**



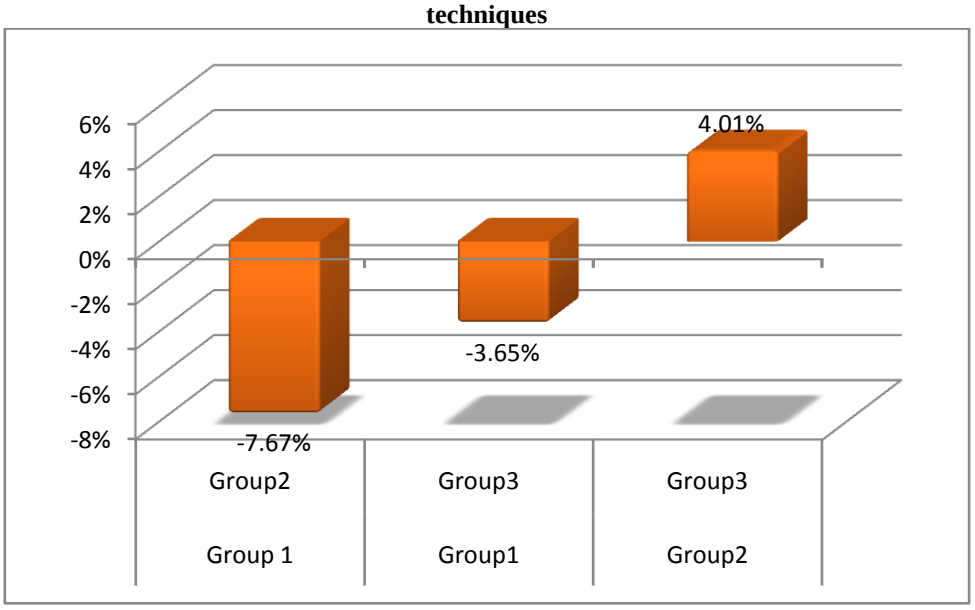

**Graph 6: Pairwise Comparison of post obturation volume (cc) in between three different obturation techniques**



**Graph 7: Comparison of percentage volume obturation of root canals with three different obturation techniques**




**Graph 8: Pairwise Comparison of percentage volume obturation in between three different obturation techniques**



**PHOTOGRAPHS**

**Fig. 1DECORONATION OF TEETH SPECIMEN**

**Fig.2 APPLICATION OF NAIL VARNISH TO THE SPECIMENS**

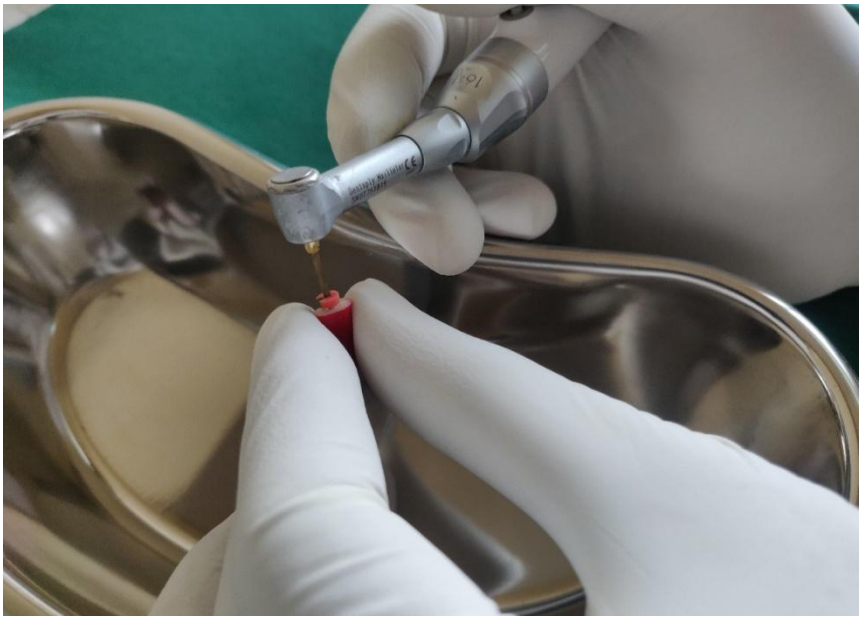


**Fig.3 BIOMECHANICAL PREPARATION OF SPECIMENS USING PROTAPER GOLD ROTARY SYSTEM**

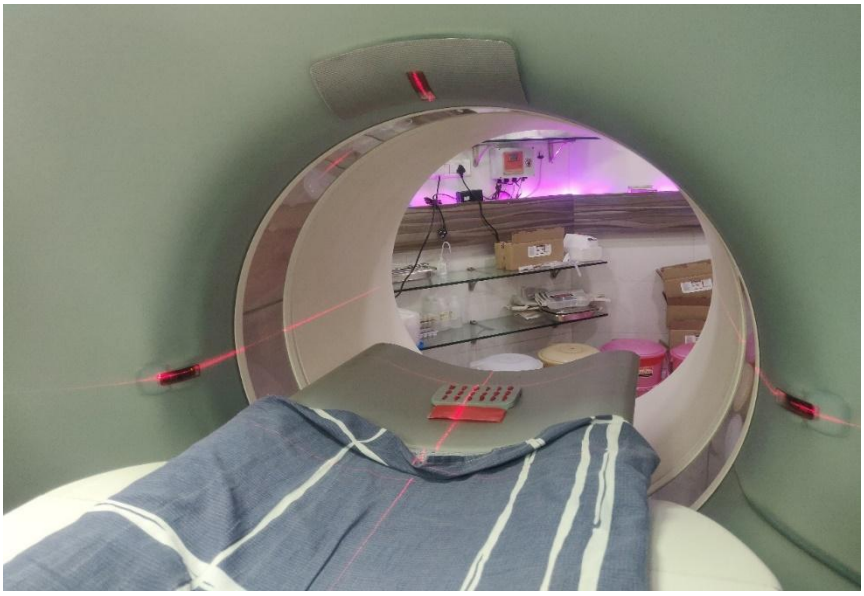


**Fig. 4 POST BMP SCANNING OF THE SPECIMENS UNDER SPIRAL CT**

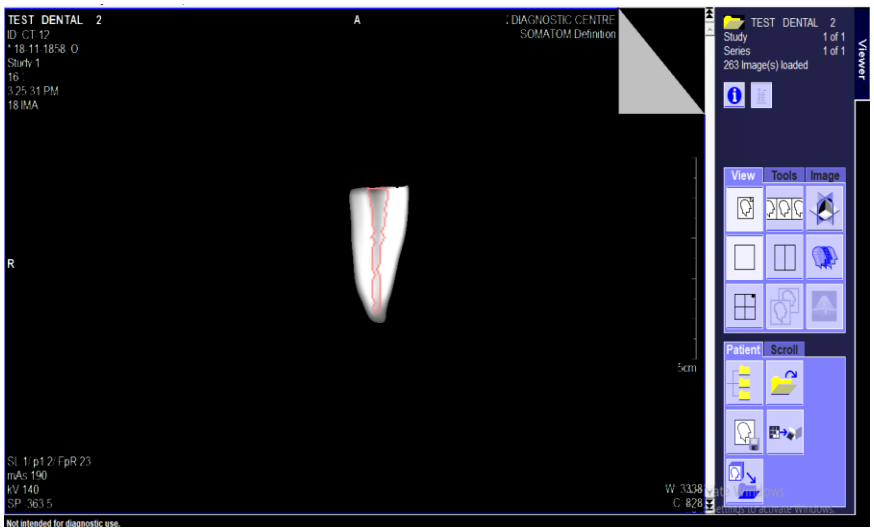



**Fig.5 POST BMP VOLUME MEASUREMENTS USING SYNGO SOFTWARE**

**Fig. 6 OBTURATION OF ROOT CANAL SPACE USING LATERAL CONDENSATION TECHNIQUE**


**Fig. 7 HEATING OF GUTTACORE OBTURATOR IN OVEN FOR OBTURATION USING GUTTACORE TECHNIQUE**


**Fig.8 OBTURATION OF CANAL SPACE USING OBTURA III MAX TECHNIQUE**

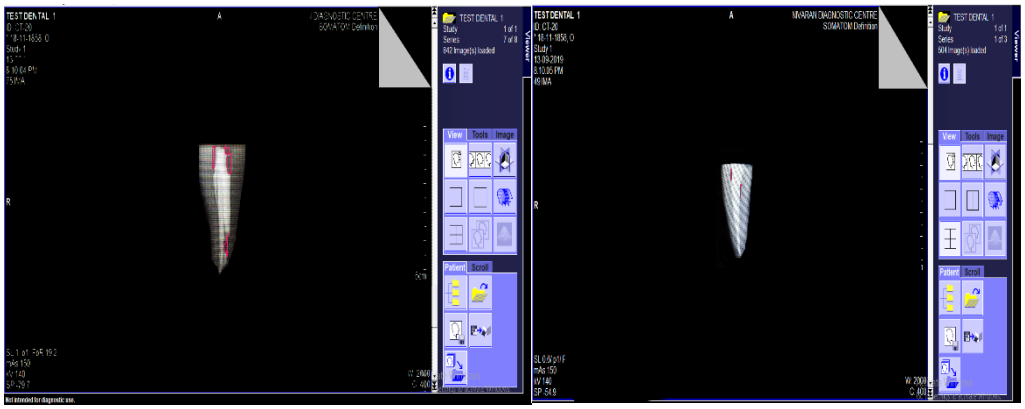


**Fig. 9 MEASUREMENT OF POST OBTURATION VOID SPACE VOLUME USING SYNGO SOFTWARE**

## IV. Discussion

The three-dimensional obturation of the root canal system helps to seal all the portals of microbial entry into the root canal space leading to secondary infection. Endodontic treatment failures mainly occur due to the inadequate obturation of the root canal space.[1] Hence, the quality of the obturation determines the long-term success of the endodontically treated tooth. Yu Hong Liang determined the association between the quality of the root canal filling and the formation of periapical lesions. The outcome of root canal treatment was said to be improved when the root canal filling is 0–2 mm from the apex and when there are no voids present in the complete obturation.[56]

In this present study 36 teeth with single root canals were selected. The samples were then grouped into three groups of 12 samples each. This helps in the inter group comparisons as well as in the intra group comparisons for the presence of voids in the obturated root canals. The working length for the study was standardized at 15 mm length. In order to reduce the variability in the results all the root canals were prepared by the same operator using a standard cleaning and shaping protocol (crown down technique). In this study, cleaning and shaping was performed by the crown down technique using the ProTaper rotary system. Nickel titanium rotary instruments such as ProTaper have a triangular cross-section that enhances the cutting action and leads to Freduction in the rotational friction between the blade of the file and dentin. Rotary instruments having this geometry are seen to cut dentin more effectively and hence they may reduce the torsional loads.[59]

As complete sealing of the root canal space is one of the most essential criteria in the obturation of the root canal system, root canal sealers are used along with the core material to obtain a fluid tight seal. According to Tronstad et al**.** a complete radicular seal is as important as the coronal seal to maintain a proper periodontal health.[71] Studies by Schafer andZandbiglari have proved that the conventional zinc oxide eugenol and calcium hydroxide-based root canal sealers do not provide an adequate radicular seal.[72] So in order to improve the

sealing properties, AH series of sealers were developed before 50 years. AH Plus is a mixture of epoxy-amines and is produced as a result of improvement in the AH-26 sealer. This sealer is used frequently as a control material for research purpose.[73] A preoperative Spiral CT analysis was done to evaluate the volume of the entire root canal space of all the study samples. Spiral CT 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.

After obturation of the prepared samples by using the three different obturation techniques volume of the obturation was evaluated in all three groups. A well condensed root canal filling should be free of voids in the coronal, middle and apical segments. In this study, the presence or absence of voids was compared among the three different groups. The prevalence of internal void is less relevant from a clinical point of view because, they provide an unfavorable environment for the bacteria that remain in the root canal system. These voids are caused due to unsuccessful adaptation of the filling materials due to air entrapment between the filling materials and the root dentin. When such voids are present, the potential risk for microleakage is likely to be increased.[80]

It is important to obturate the whole length of root canal, also the presence of voids in the apical third is very important. Based on the results of the present study, voids were detected in all the groups. The highest overall void volume was detected in CLC group which was followed by Obtura III MAX and GuttaCore. The highest volume of obturated material is seen in GuttaCore followed by Obtura III MAX and Cold Lateral Compaction.

## V. Conclusion:

Within the limitations of this study, the following conclusions were drawn:

1. When the conventional lateral compaction was compared with other two techniques namely, GuttaCore and Obtura III MAX, other two systems showed significantly high percentage of obturated volume.
2. Core-carrier obturation (GuttaCore) technique exhibited highest overall volume percentage of the obturated material followed by Obtura III MAX and Lateral condensation technique.
3. Lateral Compaction group showed the least overall volume percentage of the obturating material than other two technique.

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