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# Comparative Evaluation Of Different Sealers For Their Dentin Adaptation Using Sem And Cbct: An In Vitro Study

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**Abstract**

**Aim:-** To evaluate and compare the dentinal adaptations of four different root canal sealers using scanning electron microscopy and cone beam computed tomography.

**Materials and methods:-** Forty eight freshly extracted, intact and non-carious human mandibular first premolars were collected. The teeth were debrided and cleaned thoroughly. After disinfection in 10% thymol solution, these were verified radiographically for the presence of single root. The teeth samples were grouped into four groups according to the sealers used for obturation with gutta percha. Group I: Endomethasone N, Group II: AH Plus, Group III: Apexit Plus, Group IV: GuttaFlow Bioseal. The teeth were decoronated after obturation. They were observed under CBCT to examine the sealer-dentin interface and evaluated for the presence of gaps at the interface. After examining through CBCT, the teeth were sectioned longitudinally and examined at sealer-dentin interface for gaps through SEM at 1000x magnification for coronal, middle and apical portions of the root.

**Statistical analysis:** All the quantitative variables derived from CBCT and SEM analysis, were summarized as Means & Standard deviations. One way ANOVA test along with post hoc Tukey's test was used for intergroup comparison of variables related to the sealing ability of sealers. The level of statistical significance was <0.05.

**Result:** At the coronal level, the Endomethasone shows the void score at 5.013 ± 1.599; the AH Plus shows score at 3.579 ± 1.571. the AH Plus shows score at 3.108 ± 0.971; the GuttaFlow Bioseal has the score 4.929 ± 1.815.

**Conclusion:** Within the limitations of the study, on SEM examination the coronal aspect revealed that AH Plus sealer shows the highest adaptation and GuttaFlow Bioseal the least adaptation to the root dentin.

**Keywords**: Scanning electron microscope, Cone beam computed tomography, GuttaFlow Bioseal sealer

## Introduction

The quality of obturation is considered good when it is three-dimensional seal is achieved and it also helps in the success of root canal treatment. Since gutta-percha is not adhered to the canal wall, root canal sealers are used to fill microscopic space remaining between canal wall and in between gutta-percha. Thus, fluid tight seal (three-dimensional obturation) is achieved. If adaptation of sealer to the dentinal wall is not good, then microleakage with infected

material from oral environment or apical leakage into the canal may occur.

Since there are varieties of sealers used since 1936 they can be either zinc oxide based, epoxy resin based, calcium hydroxide based. [1] The zinc oxide based sealer has the disadvantage that it dissolves from the canal wall due to high solubility. Therefore certain modification has been done so as to improve its property. Among those one is the Endomethasone N. AH Plus or the epoxy resin based sealers show the property of expansion which reduces microleakage. [2] Calcium hydroxide based sealer is developed with the aim to use their bioactive potential that helps in healing in the periapical region.[3] Recently, bioceramic sealer has been developed with the aim to improve periapical healing with their bioactive potential and biocompatibility. Endosequence, iRoot RCS and GuttaFlow Bioseal are different bioceramic based root canal sealers [4], among these GuttaFlow Bioseal contains both gutta percha as well as biosilicate particles. Therefore it can improve the obturation quality.

Adaptation of sealer is generally studied by microleakage studies such as by dye penetration method and dye extraction method, bacterial penetration method; fluid infiltration method and examination under magnifications like stereomicroscope and Scanning Electron Microscopic scan etc. Recently 3D imaging techniques are being used in the medical and dental fields. Micro-CT and CBCT are in use for the diagnosis and treatment planning in dentistry. Here three-dimensional images can be observed in different angles. Since, factors like cost and availability of micro-CT is much compromised hence, CBCT has become popular in the field of dentistry to examine the adaptation of sealer to dentinal wall. Also the Cone Beam Computed Tomography (CBCT) that is becoming increasingly popular for use in endodontics. Many studies were done to see adaptation of sealers with SEM but very few studies were found with CBCT that were carried out so far. Hence, our aim is to use both the CBCT and SEM for evaluating the adaptation of four sealers – Endomethasone N, AH Plus, Apexit Plus and GuttaFlow Bioseal to the root canal dentinal wall. The proposed null hypothesis is there will be no variation in the adhesive interface of the four different sealers.

**Materials And Method:-**

Forty-eight freshly extracted, intact and non-carious human mandibular first premolars were collected from the Department of Oral and Maxillofacial Surgery of the institute. The debris was cleaned from the teeth using ultrasonic scaler. To disinfect, all the teeth were stored in 10% thymol solution at room temperature before using in the procedure for the experiment.

The inclusion criteria were single rooted teeth with single canal, intact crown and fully formed apices, age from 15 to 40 years and any defect such as caries, attrition, abrasion, resorption and erosion were excluded.

In all the teeth access cavities were prepared using an air turbine hand-piece and glide paths were established. Working length was determined using ISO no. 15 size K- file keeping 1mm short of the anatomical apex. Cleaning and shaping were performed using ProTaper Universal Rotary NiTi files from Sx up to F3 in sequence using Crown-down technique. During instrumentation 2.5% sodium hypochlorite was used intermittently after each use of file and final irrigation performed with 17% ethylene-diamine tetra acetic acid (EDTA) so as to remove the smear layer. The master gutta percha cone was selected according to the last used file size after the instrumentation has been completed and verified up to the working length with intra-oral periapical radiograph.

After the biomechanical preparation all the teeth had been divided into four groups as follows according to the sealer used for obturation: Group I: Endomethasone N, Group II: AH Plus, Group III: Apexit Plus, Group IV: GuttaFlow Bioseal. The sealer was applied inside the root canal wall with a lentulospiral at speed of 300 revolutions per minute (rpm) using micromotor with contra-angle handpiece. The gutta percha was coated with the mixed sealer and applied up to the working length. The obturation was performed by lateral condensation technique. The gutta percha was coated with the mixed sealer and applied inside the root canal. The excess gutta percha was then removed and the coronal orifice was sealed using a heated small-ended ball burnisher instrument. The access cavity was then restored with zinc oxide eugenol temporary dressing.



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The teeth specimens were stored in normal saline solution for 48 (forty-eight) hours for the sealer to get set. All forty eight teeth samples were mounted vertically in modelling wax block. Cone beam computed tomographic scan was done by rotating those three- dimensionally with the machine for evaluating the voids present.

After performing CBCT scan, the sample teeth were prepared for examination with scanning electron microscope.[5] The teeth were decoronated 2 mm above the cemento-enamel junction using diamond coated discs and roots were sectioned vertically in bucco-lingual dimension with the same, and each section was placed in aluminium stub and sputter coated with gold and were observed with Scanning electron microscope (SEM) under 1000x magnification and the presence of gap were measured at the sealer- dentin junction in the coronal, middle and apical thirds.

**Statistical Analysis:**

A Shapiro-Wilk's test showed that the collected data were normally distributed for all the four study groups. Repeated Measures Analysis of Variance(ANOVA) with *post-hoc* Bonferroni's test and the paired-samples t-test was used to compare the void scores across cross-sectional levels and imaging modalities respectively for each of the study groups. One-way Analysis of Variance(ANOVA) with *post-hoc* Tukey's HSD test was used for inter-group comparisons . The *P*-value of 0.05 was considered as the level of significance.

**Results**

**Table 1.1: Mean±S.D (in (µm) of the void scores at each cross-sectional levels assessed by SEM and CBCT for the study groups**

| Groups | Imaging Modalities | Coronal | Middle | Apical | *P* value § [Coronal vs Middle Vs Apical] | *P* value # [SEM vs CBCT] |
|---|---|---|---|---|---|---|
| **Group A** | SEM | 3.66±1.47 a | 3.25±0.952 a | 2.94±0.878 a | 0.28 ns | <0.001** |
| | CBCT | 700±266 | 700±191 | 658±281 | 0.86 ns | |
| **Group B** | SEM | 4.94±1.51 ab | 4.31±0.694 abc | 4.31±0.994 b | 0.32 ns | <0.001** |
| | CBCT | 633±264 | 650±228 | 683±248 | 0.96 ns | |
| **Group C** | SEM | 5.29±1.37 b | 5.05±1.72 b | 3.97±1.53 ab | 0.15 ns | <0.001** |
| | CBCT | 592±215 | 667±284 | 533±242 | 0.42 ns | |
| **Group D** | SEM | 4.5±1.16 ab | 3.6±0.885 ac | 3.69±1.04 ab | 0.06 ns | <0.001** |
| | CBCT | 567±202 | 692±278 | 608±281 | 0.49 ns | |
| ***P* value $ [A vs B vs C vs D]** | SEM | 0.04 * | 0.002** | 0.034 * | | |
| | CBCT | 0.54 ns | 0.95 ns | 0.52 ns | | |

Total sample size:48; sample size per group:12

§: analyzed by the one-way ANOVA test



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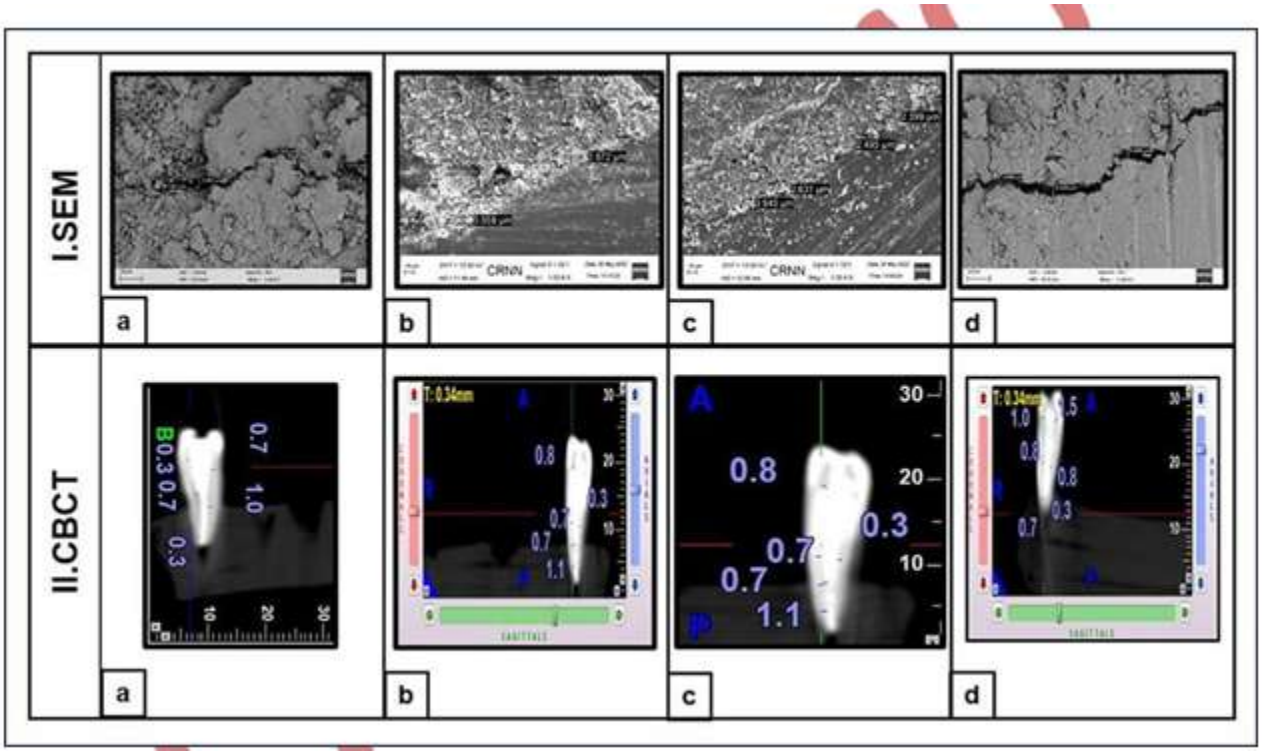
#: analyzed by the paired samples t-test

$: analyzed by the repeated measures ANOVA test

ns: not significant ($P$>0.05); * Significant at $P$<0.05**: Highly significant ($P$<0.001)

Different superscript lowercase letters denote statistically significant difference between rows of the same imaging modality(between/inter-group comparisons)

**Representative images**




**Discussion:**

The canal system should be sealed apically, coronally and laterally to create fluid tight seal. Unfortunately all materials and techniques result in leakage. A number of methods and materials have been developed to achieve a fluid-tight seal of the root canal system for optimum results after endodontic treatment; however, none has been successful in achieving a complete seal. This in vitro study is performed so as to evaluate the marginal adaptation of root canal sealers to the root dentinal wall. During filling inside the root canal, there is incorporation of air in the interface between the material and the dentinal wall and also inside the sealer as well. This can interfere with the adaptation of the sealer to the canal wall and hence there can be the phenomenon of microleakage that may lead to secondary infection of the root canal. In an early radiographic study of success and failure, Ingle indicated that 58% of treatment failures were due to improper obturation.[5]

Teeth with straight root canals only were used because they can offer a more standardized method for evaluation of sealer adaptation. Recently, confocal laser scanning microscopy, micro-CT analysis and cone beam computed tomographic observations have been in use for such evaluation. In this study scanning electron microscopy has been used since it can examine the marginal adaptation of the sealers in very fine magnification as compared to the other above mentioned techniques in shorter time, where no preparation of the samples other than coating with conductive material is done. Scanning Electron Microscope has greater resolution, improved interface magnification, and superior field depth, which has also been stated by Punithia and Shashikala in 2018.[6] The gaps at the interface can be very minutely observed from the scanned digital images and is readily measured. The cone beam computed tomography gives three dimensional images of the specimens. CBCT scan can be used to observe the adaptation of root canal sealers because it



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provides three-dimensional images of the specimens. The advantage of CBCT scan is that it does not require sectioning of teeth. It uses X-rays to get digital images of the samples which are examined to assess the adaptation of root canal sealers. Literature review revealed very few study to observe these adaptation with CBCT. One of the study performed by Samia ME and Inas AA in 2019, in which they studied the quality of two different obturation techniques using CBCT. Hence herewith in this study,[7] CBCT scan is taken to examine sealer adaptation and compare it with scanning electron microscope which is considered as the gold standard technique to examine specimen in different magnifications ranging from 50x- 50000x. This study showed no statistically significant difference in the mean scores among the sealers as examined through scanning electron microscope in the coronal and apical portions of the root canal. The mean difference in the scores among the sealers was not found to be statistically significant when examined with cone beam computed tomography in all the three portions of the canal. There can be presence of voids while obturating an endodontically treated tooth with sealer because of their aforementioned characteristics, the amount of voids or gaps may vary when measured between the sealer part and radicular dentin interface. Hence, to assess this comparison amongst the sealers the lengths of gaps are measured using the scanning electron microscope and cone beam computed tomography. In the present study, Endomethasone has shown the highest mean score in the apical part (4.164 ± 0.99) among other sealers revealing the least adaptation which is similar to a study by Abid Lankar et al. in 2018 [8] where there is the maximum microleakage at (1.13 ± 0.48 mm). The presence of voids between the sealer surface and the canal wall was in highest number in every samples amongst the other sealers used with the highest mean scores at all the cervical, middle and apical parts of the teeth in our observation.

In a study by Attur KM et al. in 2017,[9] they also found that the zinc oxide eugenol sealer had the highest microleakage throughout the canal wall in the cervical, middle and apical parts with a mean value of 1.46 ± 0.776. U. Salz et al. in 2009 [10] evaluated bacterial leakage in a study between Apexit Plus and AH Plus and found that Apexit Plus has better sealing ability than the other sealer which is in contrast with our study. A study done by Ronald Ordinola Zapata et al. (2009) [11] with lateral compaction technique concluded that Sealapex, a calcium hydroxide based sealer showed the greatest penetration inside dentinal tubules at both 3mm and 5mm length from the apex, compared to GuttaFlow which reveals greater adaptability to root dentin than the latter. AH Plus has shown the lowest mean score in presence of voids at all the coronal, middle and apical portions of the canal in our study among other sealers use suggestive of better adaptation of sealer with the dentinal wall. It is in accordance with the study by Vimal Remy et al. in 2017 [12] where they had observed the highest score for marginal adaptation in both coronal and middle aspects. In this present study, the mean score of voids at the coronal portion is 3.57 ± 1.57 and at the apical portion is 2.93 ± 0.95. In a study done by Widcha Asawaworarit et al. (2020) [13] with scanning electron microscope which was used to assess the adaptation and penetration of sealers and observed that Endosequence BC has better ability to penetrate into the dentinal tubules in the apical third of the root canal as compared to AH Plus sealer. They concluded that the bioceramic sealer has better sealing ability than the resin based sealer. Regarding the CBCT analysis, the mean value is not statistically significant in any of the group. The GuttaFlow Bioseal reveals the lowest mean score on CBCT evaluation at the coronal aspect, whereas there is no significant mean difference between the scores of Endomethasone N and AH Plus. The AH Plus reveals the highest mean score on CBCT evaluation at the apical part, whereas GuttaFlow Bioseal is showing the least score. The intergroup comparison amongst the sealers with SEM and CBCT evaluation signifies no significant difference. The AH Plus reveals the highest mean score on CBCT evaluation at 0.67 ± 0.294, whereas on SEM evaluation it is 2.939 ± 0.959 where it is lowest.

Since this is an in vitro study hence, the results may vary if the study is performed in in vivo technique. Studies are required to be done in the other method. During the section of samples for examining through SEM there may be inadvertent fracture of the gutta percha and hence evaluation for adaptability may be difficult and also during coating of teeth with the metal, void may get incorporated which if not vacuumed properly may give variable results. For the



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CBCT, the resolution of the scanned image is lower and the voxel thickness may not be examined well.

**Conclusions:**

Within the limitations of the study, on **SEM examination the coronal aspect** revealed that AH Plus sealer shows the highest adaptation and GuttaFlow Bioseal the least adaptation. On **CBCT examination** the AH Plus showed the highest adaptation and Apexit Plus the least adaptation and GuttaFlow Bioseal showed better adaptation than Apexit Plus.

On SEM examination in the **middle aspect** revealed AH Plus to have the highest adaptation while GuttaFlow Bioseal the least. On **CBCT examination**, AH Plus and GuttaFlow Bioseal shows the highest adaptation and the least adaptation is shown by Endomethasone N. Apexit Plus reveals better adaptation than Endomethasone N.

On SEM examination in the **apical aspect**, AH Plus revealed the highest adaptation on **SEM examination** and lowest is revealed by Endomethasone N. Apexit Plus showed better adaptation than Endomethasone and GuttaFlow Bioseal, but on **CBCT examination** GuttaFlow Bioseal revealed the least score.

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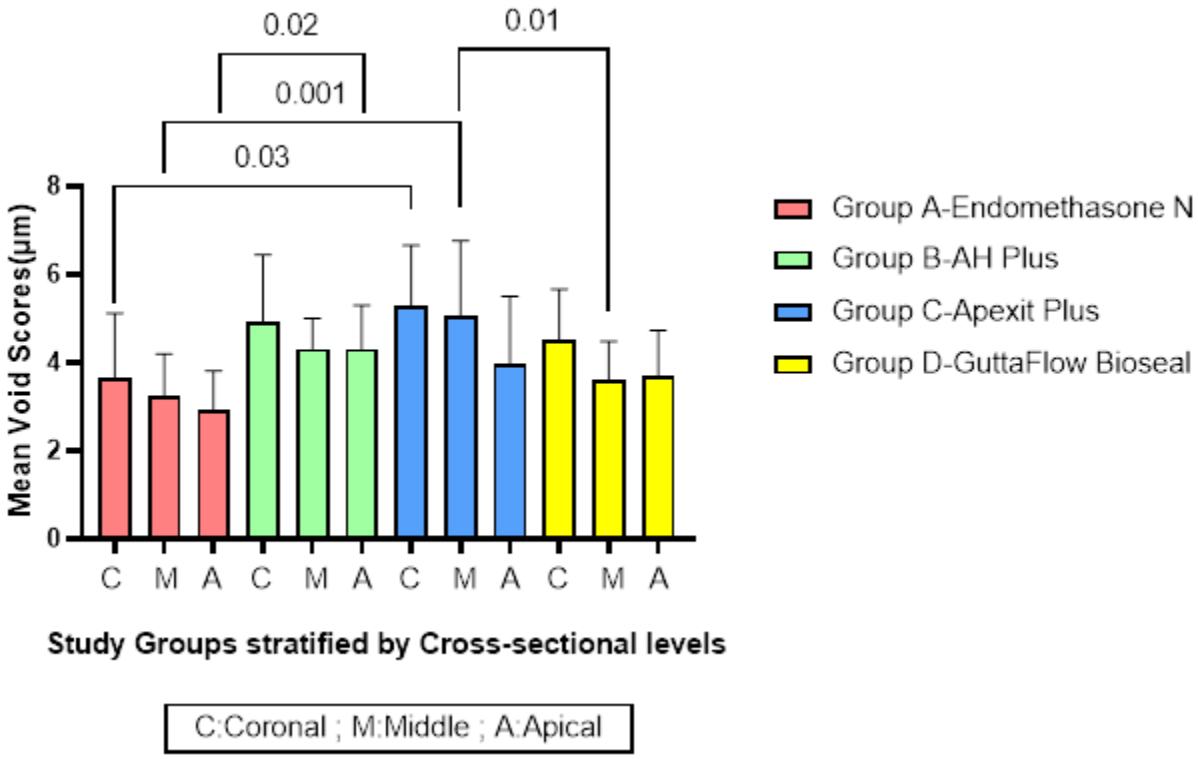
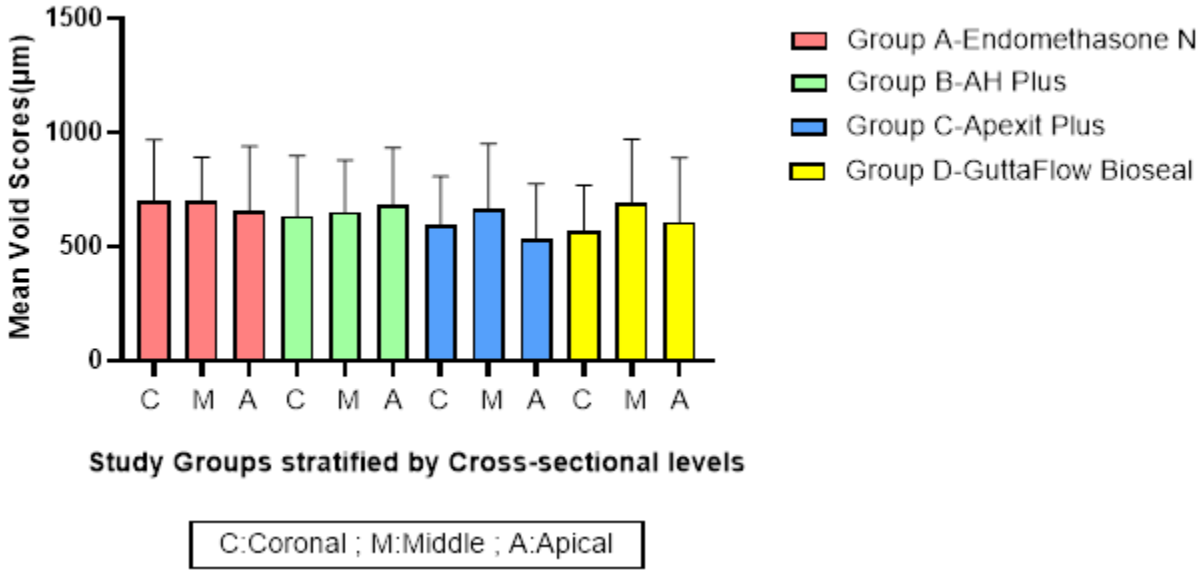
**Bar Graph: Void scores at each cross-sectional levels assessed by SEM for the study groups**




**Bar Graph: Void scores at each cross-sectional levels assessed by CBCT for the study groups**



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