



MICRO-CT ANALYSIS OF VOIDS AND GAPS FORMATION IN DIFFERENT BIO-CERAMIC SEALERS AND 2 OBTURATION TECHNIQUES

OBJECTIVE

BACKGROUND

Bioceramic sealers are widely used in root canal obturation due to their excellent properties, such as biocompatibility, bioactivity, high flowability, and dimensional stability. This has shifted obturation techniques from traditional gutta-percha to sealer-based methods, with the single cone technique being preferred for its simplicity and effectiveness. However, concerns about gap and void formation exist due to the lack of compaction in this technique, which could affect sealing and treatment outcomes. Studies, including those by Kim *et al.*, suggest that combining the single cone technique with ultrasonic activation reduces void formation, improving the quality of root canal fillings and clinical outcomes.

RESULT

Table 2: The percentage of open void(V%) and total void(V%) from micro-CT scans at each level of roots

	Region	Median Rank	Test statistic of Friedman Test	p-value	Pairwise Comparison
Percentage of open void	Cervical	3.17 ^a	37.567	<0.001	C vs M; 0.007 C vs A; 0.001 M vs A; 1.00
	Middle	1.96 ^b			
	Apical	1.74 ^b			
Percentage of total void	Cervical	3.19 ^a	36.008	<0.001	C vs M; 0.001 C vs A; 0.001 M vs A; 1.00
	Middle	1.96 ^b			
	Apical	1.76 ^b			

No significant differences in voids and gaps formation between:

- Single Cone technique and Single Cone technique with ultrasonic activation ($P > 0.05$).
- CeraSeal™ and iRoot SP materials ($P > 0.05$).

A higher incidence of both voids and gaps formation was observed in the cervical third of the root canal compared to the middle and apical thirds ($P < 0.05$).

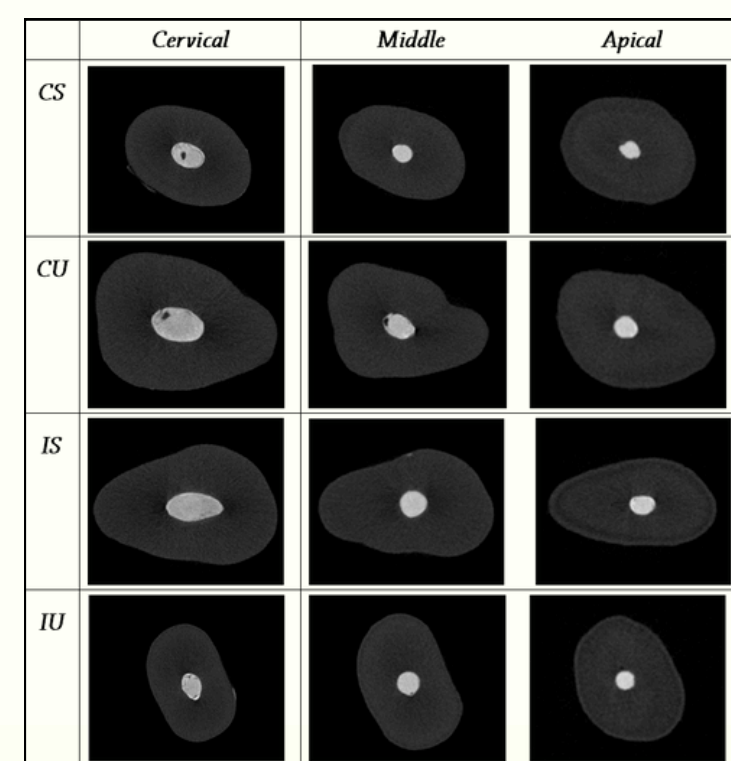
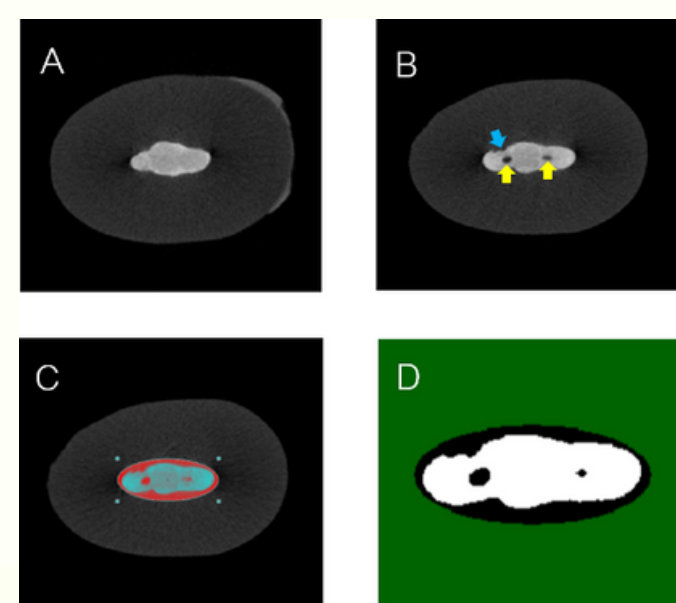


Figure 1: Renderings of two different root canal sealers and techniques, scanned with μ CT, showing cross-sections of the cervical, middle, and apical thirds. (CS) CeraSeal™ using Single Cone Technique, (CU) CeraSeal™ using Single Cone Technique with ultrasonic activation, (IS) iRoot® SP using the Single Cone Technique and (IU) iRoot® SP using the Single Cone Technique with ultrasonic activation

Figure 2: Representative μ CT images showing (A) no void, (B) Blue arrow shows open pores and yellow arrows show close pore, (C) Region of interest (ROI) selection on images, and (D) Void detection within ROI



DISCUSSION

The main function of an endodontic sealer is to inhibit intracanal leakage, and its sealability should be assessed to evaluate this requirement. Sealability is typically evaluated through visual assessment of filling quality. This study evaluated the sealability of calcium silicate-based endodontic sealers, specifically CeraSeal™ and iRoot® SP, by analyzing the volume percentage of filling voids using micro-CT. Both materials demonstrated favorable properties, including small particle size (less than 2 μ m), optimal viscosity and minimal or no shrinkage during the setting phase (Nagas E *et al.*,2012, Ersahan S *et al.*,2010).

In this study, two obturation techniques, Single Cone (S) and Single Cone with Ultrasonic Activation (U), as well as two root canal sealers, CeraSeal™ (C) and iRoot® SP (Jianing J *et al.*,2021), were compared. We hypothesized that the ultrasonic waves from the device pass through both the cotton pliers and the gutta-percha cone, which reduced the strength of the vibrations reaching the GP cone, allowing them to remove trapped air bubbles without affecting the sealer's integrity. Although ultrasonic activation is suggested to enhance filling quality by Kim *et al.*, the results revealed no significant differences between the techniques.

Our results demonstrated a significantly higher incidence of both total and open voids in the cervical third of the root compared to the middle and apical thirds. In contrast, the apical and middle thirds of the root were more uniformly obturated across all experimental groups. It is well established that non-obturated apical areas can harbor bacteria, potentially leading to treatment failure (Saunders WP *et al.*,1994, Somma F *et al.*,1994). Based on the limitations of this study, we can only confirm that the apical and middle thirds of the root canal exhibited fewer void and gap than the cervical third. However, further research is required to determine whether these findings are directly related to root canal failure and to assess the clinical implications of these observations.

ADVISORS



Siripat Lertnantapanya
DDS.



Prattana Yodmanotham
DDS.

RESEARCHERS



Wimsiri Uaariyapulphong
5900183



Chonradee Pornteerapat
6000082



Manunya Sujjapong
6000109



Chayaporn Sungworawongpana
6102052



Pichsinee Thana-anawat
6102168

STATISTIC ANALYSIS

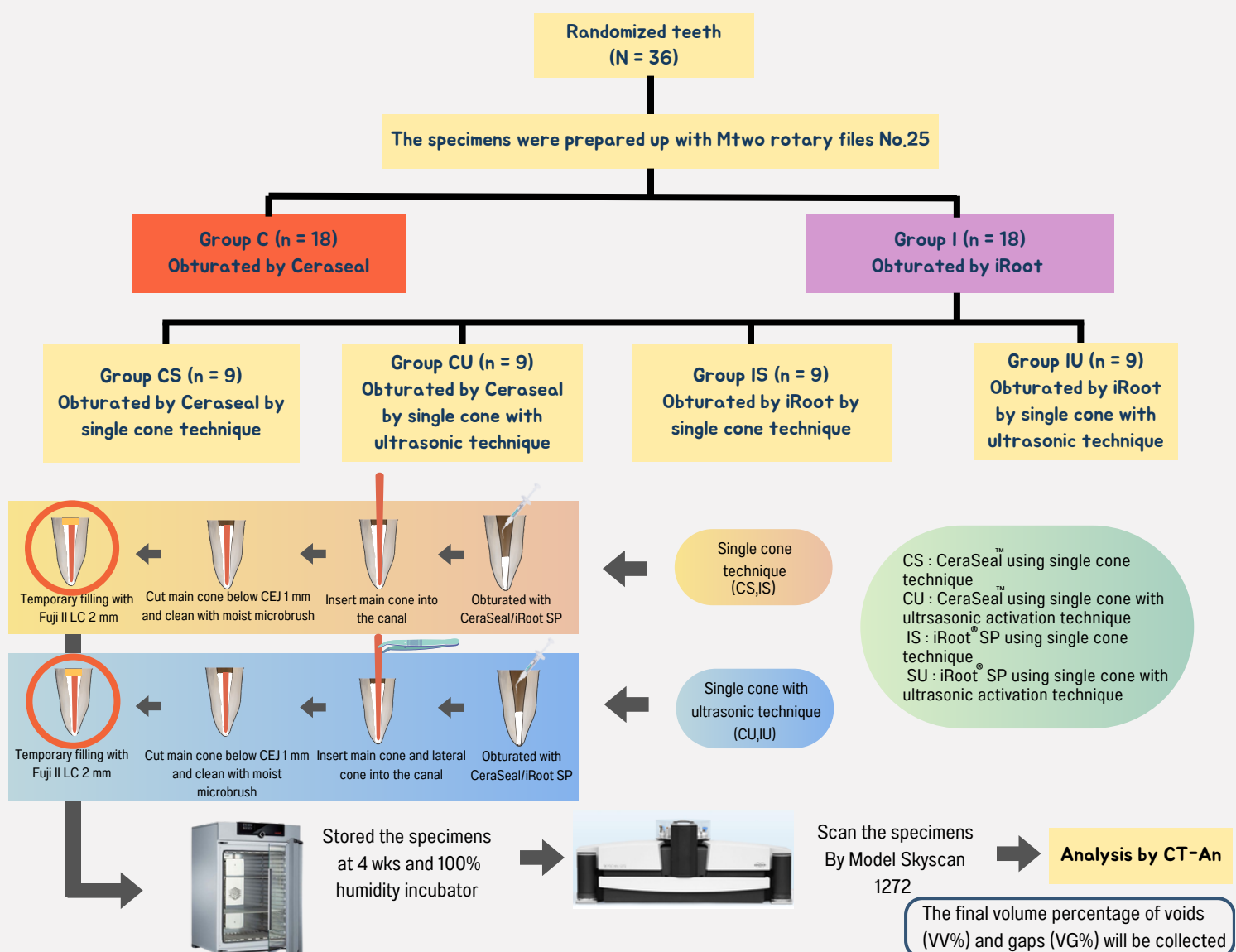
This study aims to compare the performance of CeraSeal™ and iRoot SP using two obturation methods: the single cone technique and the single cone technique with ultrasonic activation, by evaluating void formation and gaps through Micro-CT imaging.

All statistical analyses were conducted using SPSS software version 25.0. The normality of the data was assessed using the Kolmogorov-Smirnov test. The Kruskal-Wallis test was used to evaluate significant differences in the final volume percentage of voids and gaps between experiment groups, while Friedman's test was employed to assess differences across the different parts of the root canal. A significance level of $P < 0.05$ was considered statistically significant.

MATERIALS & METHODS

Table 1: Materials and compositions used in the experiment.

MATERIALS	MANUFACTURER	COMPOSITION	MIXING	LOT/Exp
CeraSeal™	Meta Biomed Co., Cheongju, Korea	Calcium silicates, Zirconium oxide, thickening agent	Premixed (auto-mixing tip)	CSL2403181 2526-03-17
iRoot® SP	Innovative Bioceramic, Vancouver, Canada	Zirconium oxide, Calcium silicates, Calcium phosphate monobasic, Calcium hydroxide, Filler, thickening agent	Premixed (auto-mixing tip)	240015P 2026-03-31



CONCLUSION

The obturation technique and sealer type did not significantly impact void and gap formation. Both sealers and techniques demonstrated comparable efficacy in achieving a homogeneous root canal filling, particularly in the apical region. However, the results indicate that the coronal section is less uniform compared to the apical and middle sections.