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Sealing Ability of Guttacore, Thermafil and Conventional Gutta Percha Using Different Resin Sealers

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Abstract

Background and objectives: The success of root canal therapy hinges on achieving a tightly sealed closure at the apical end of the root canal. This study aimed to compare the sealing effectiveness of root canal obturation using various materials for obturating cones and sealers.

Material and methods: This experimental in vitro study conducted from June 2022 to June 2023 in the Duhok city in the medical lab of collage of medicine. Ninety extracted human single canal premolars were used, prepared by wave one gold medium size file (35/0.06), irrigated by 2.5% sodium hypochlorite. Divided into six groups, three of obturating cone, two carrier-based (GuttaCore and Thermafil) and one conventional gutta-percha. These groups were further subdivided into 15 teeth each, distinguished by the sealers used: Ceraseal (MetaBiomed Co., Cheongju, Korea) and AH Plus (epoxy resin-based sealer).

Results: Comparing types of obturating cone and sealers, the sealing ability of Ceraseal sealer with guttaCore is (26.77), with better sealing ability of thermafil (12.10) and with conventional gutta-percha (30.15) with p-value of <0.001. while the sealing ability of AH plus with guttaCore is (33.73), with thermafil (20,07) and with good sealing ability of conventional gutta-percha is (15.20) with p-value <0.001. The difference is significant for both groups.

Conclusion: The sealing ability of the materials used to regard obturating cone and sealers were not able to fill the root canal completely without leaving gabs. Thermafill gutta-percha with Ceraseal sealer had a maximum area of root canal filled.

Keywords: GuttaCore, Resin sealers, Scanning electron microscope, Sealing ability, Thermafill

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Introduction

The success of treatment of root canal is to get rid of infection-causing microbes from the root canal; however, anatomical complication of the root canal system makes the eradication of microorganisms not always possible.[1,2] The last step in root canal treatment involves meticulously filling the entire internal space of the tooth's root including main canal, interconnected channels, branches, or smaller side canals. The filling material must create a hermetic seal, preventing any leakage or re-entry of bacteria from any direction within the tooth. This is essential to ensure the long-term success and effectiveness of the root canal treatment.[3,4] Root canal sealers lubricate the area during the obturation process, fill all the tiny canals, make the sealing process easier.[5] Carrier-based obturation Thermafil is a simplified and efficient method with little implementation time. Researches and manufacturers suggests that this carrier system exhibits less leakage than vertical and lateral condensation techniques, indicating its potential as a reliable and clinically effective obturation method.[6] Dentsply Sirona, based in Switzerland, has introduced a new core-carrier system featuring GuttaCore, a cross-linked gutta-percha material, replacing the traditional plastic carrier in their Thermafil product line.[7] GuttaCore, the new core obturator, is fully composed of gutta-percha, utilizing cross-linked gutta-percha for its core structure.[8] The development of Carrier-based obturation is to streamline the root filling process. However, when it comes to retreatment, entire removal of these systems is difficult and time-consuming.[9] The residual filling material left behind after a retreatment procedure can act as a barrier, preventing disinfecting agents from effectively reaching and acting upon the canal walls.[10] CeraSeal a newer type of sealer with its antiseptic properties which made from calicium and silicate, had a fast development in the last few years for their biocompatibility and bioactivity.[7] These sealers possess a distinct advantage: they can penetrate into the dentinal tubules and interact with the moisture naturally present within the dentin. This interaction facilitates bonding between the core filling materials and the dentin, which helps minimize shrinkage and promotes dimensional stability.[8] It also releases bioactive substances that strengthen the connection between the sealer and dentine.[11] AH Plus®, an epoxy resin-based sealer, is widely recognized as the gold standard in endodontic obturation. This is attributed to its strong adhesion to dentin, visibility on X-rays, smooth flow, long-lasting due to its low solubility and high resistance.[5] Therefore, the perfect root canal sealer should set slowly, melt with saliva, minimize any inflammation and prevent microbial contamination to prevent infection, all these features allow successful root canal filling.[12] The most important properties; forms a hermetic seal, bacteriostatic, biocompatible, does not stain tooth structure, displays a slow setting, and is insoluble in host tissue fluids.[13] Microleakage is the major problem that lead to endodontic failure.[14] Confocal laser microscopy, scanning electron microscopy (SEM), leakage tests, and digital imaging are techniques commonly used in endodontic research to examine root canal morphology, evaluate sealers and obturation techniques, assess microleakage, and capture detailed images for analysis.[15] This study aimed to use scanning electron microscopy to evaluate and compare the sealing effectiveness of root canal obturation using various materials for obturating cones and sealers.

Material and methods

This in Vitro study conducted on the ninety single root canal extracted teeth of human mandibular premolars, the extracted teeth were acquired from a private and public dental clinic in Duhok city. The teeth were

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disinfected using 5.25% sodium hypochlorite for 20 min. and stored in a solution of 0.1% thymol crystals at room temperature for about two weeks. Subsequently, the teeth were categorized into three primary groups (n=30) based on the specific obturation cone employed. These groups were further subdivided into 15 teeth each, distinguished by the sealers used: Ceraseal (MetaBiomed Co., Cheongju, Korea) and AH Plus (epoxy resin-based sealer). Under 20x magnification with an operating microscope (Carl Zeiss Meditec AG), teeth were carefully examined; mature teeth with straight canal selected, immature apices, any tooth with cracks or caries excluded from the study. Preoperative radiographs buccolingually and mesiodistally taken to confirm the presence of a single un-manipulated root canal that has not been previously treated or altered by endodontic procedures. At the cement-enamel junction all teeth crowns are separated from roots and each root will be adjusted 12 mm in length. Then, an Instrument from Switzerland Maillefer Dentsply was inserted into the root canal until the tip touched the apex. The exact length was determined by withdrawing 0.5 mm from this measurement. Instrumantation done for all used teeth by use of set of rotary instruments with a reciprocation movement (waveOne gold file) (Dentsply sirona) size 35/06 medium. Before tooth instrumentation, irrigation with 2 ml solution of 2.5% sodium hypochlorite (NaOCl) was performed between each instrument used. Subsequently, a final rinse of 1 minute with the same solution, followed by mix of 2 ml 17% EDTA with 10 ml distilled water, was conducted for removing the smear layer.[16] Paper points used to dry Canals. Both Ceraseal and AHplus Sealers were separately inserted inside by size #35 lentulo-spiral with istructions of manufacturers (Produits Dentaires, Switzerland) to dispense sealer uniformly throughout the canal with single cone obturation. Carrier-based gutta-percha systems such as GuttaCore and Thermafil were thermo-plasticized in the Therma-Prep oven (Dentsply, CH-1338) according to instructions from (Ballaigues, Switzerland) and then inserted into the canal during obturation with gutta-percha and sealer. Any excess gutta-percha removed using a hot instrument after twisting it off. Conventional gutta-percha was obturated by single cone size #35 cut at canal orifice. Group I consisted of 15 roots that were filled with GuttaCore GP size 35/06 and Ceraseal (S). Group II comprised 15 roots filled with GuttaCore GP size 35/06 and AH Plus (S). Group III:15 root filled with Thermafill GP 35/06 and Ceraseal (S). Group IV:15 root filled with Thermafill GP 35/06 and AHplus (S). Group V: 15 root filled with Conventional GP 35/06 and Ceraseal (S). Group VI:15 root filled with Conventional GP 35/06 and AHplus (S). After filling, the roots were incubated at 37°C with 100% humidity for 5 days to ensure even sealer distribution.[17] They were then cross-sectioned by Minitom from Struers labiolingually into coronal, middle, and apical segments (0–4 mm, 4–8 mm, and 8–12 mm respectively) which designed for sectioning delicate materials with high accuracy. It boasts an accuracy of ±0.01mm. Sections were prepared, gold-coated, and examined using a Carl Zeiss NTS Scanning Electron Microscope (SEM) at 1500X magnification. Penetration of sealer into tubules of dentin evaluated, Scores from one to three putted by gap measurements between the sealer and dentin using ImageJ software. Score (1) Exceptional adhesion; a seamless interface between the sealer and dentin without gaps, with significant sealer penetration into the tubules. Score (2): Adequate adhesion; a gently curved interface between the sealer and dentin with some gaps present between the sealer and dentin walls. Score (3): Moderate adhesion; gaps

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frequently observed between the sealers and dentin walls, with an indistinct and curved contact line at the sealer-dentine interface.[18] Statistical analyses included Mann-Whitney and Kruskal-Wallis tests to compare mean ranks among different test groups. A p-value < 0.001 was considered significant, indicating differences among the groups.

Results

The differences in mean sealing ability ranks among three types of gutta-percha (GP) combined with two different sealers (S) within dentinal tubules (D), analyzed using the Mann-Whitney test according to Table (1).

Table (1): The overall difference in the mean rank of sealing ability of the three Gutta-percha with the two Resin sealers.

Resin sealer	A GuttaCore	B Thermafil	C Conventional GP	p-value*	Between each two groups	
					Compared groups	p-value
Ceraseal sealer	26.77	12.10	30.13	< 0.001	A with B	0.006
					A with C	1.00 (NS)
					B with C	< 0.001
AH plus sealer	33.73	20.07	15.20	< 0.001	A with B	0.012
					A with C	< 0.001
					B with C	0.917 (NS)
Total (both sealers)	60.03	31.67	44.80	< 0.001	A with B	< 0.001
					A with C	0.069 (NS)
					B with C	0.151 (NS)

* By mann-whitney test

In Table (1) when paired with Ceraseal sealer, significant differences in sealing ability ranks were found: GuttaCore vs. Thermafil (p = 0.006), Thermafil vs. conventional GP (p < 0.001), but not GuttaCore vs. conventional GP (p = 1.00, NS). Thermafil showed significantly lower mean rank and good adhesion (p = 12.10), Figure (1). With AH Plus sealer, significant differences in mean ranks were observed: GuttaCore (p = 33.73), Thermafil (p = 20.07), and conventional GP (p = 15.20), indicating good adhesion with conventional GP with lower mean rank, Figure (2). Overall, GuttaCore had a significantly higher mean rank than Thermafil (p < 0.001), while there was no significant difference between GuttaCore and conventional GP (p = 0.069, NS). Thermafil and conventional GP also did not differ significantly in their mean ranks (p = 0.151, NS).

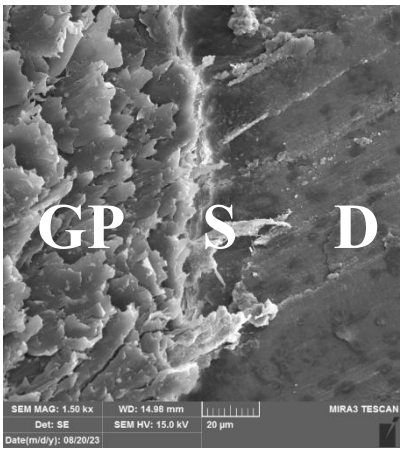

Figure (1): SEM image of Thermafil gutta percha and ceraseal sealer at apical third at(1500X)

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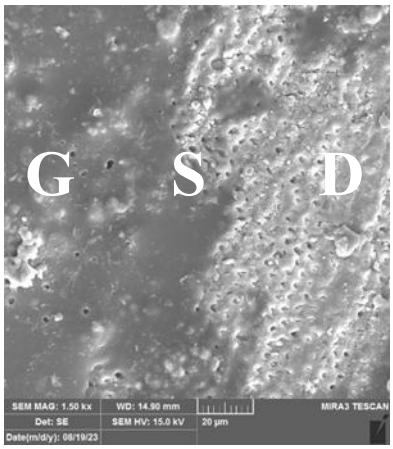

Figure (2): SEM image of Conventional gutta percha and AH plus sealer at coronal third at(1500X)

The Difference in the mean score of sealing ability of the three Gutta-perchas with two Resin sealers in Different section of the tooth at Coronal, middle, and Apical third of table (2). The Kruskal-Walli's test was used to assess differences in mean ranks between the three sections for each group.

Table(2): The difference in the mean score of sealing ability of the three Gutta-perchas with two resin sealers in different section of the tooth.

Groups of Substance used	A Coronal Mean rank	B Middle Mean rank	C Apical Mean rank	p-value*	Between each two groups	
					Compared groups	p-value
Group 1: GuttaCore with Ceraseal	12.53	27.73	28.73	0.001	A with B	0.001
					A with C	0.001
					B with C	0.832 (NS)
Group 2: GuttaCore with AH	12.27	32.57	24.17	< 0.001	A with B	< 0.001
					A with C	0.012
					B with C	0.075 (NS)
Group 3: Thermafil with Ceraseal	14.40	28.90	25.70	0.005	A with B	0.002
					A with C	0.016
					B with C	0.497 (NS)
Group 4: Thermafil with AH	15.40	30.13	23.47	0.008	A with B	0.002
					A with C	0.088 (NS)
					B with C	0.158 (NS)
Group 5: Conventional with Ceraseal	23.47	21.03	24.50	0.746 (NS)	A with B	NS
					A with C	NS
					B with C	NS
Group 6: Conventional with AH	9.20	28.47	31.33	< 0.001	A with B	< 0.001
					A with C	< 0.001
					B with C	0.538 (NS)

* By Kruskal Wallis test

As shown in Table (2); for Group 1:(GuttaCore with Ceraseal) the mean ranks were significantly different between the coronal section and the middle ($p = 0.001$) and apical ($p = 0.001$) section, but not between the middle and apical section ($p = 0.832$, NS), Figure (3) and (4). In Group 2: (GuttaCore with AH plus) the mean ranks were significantly different between all pairs of section ($p < 0.001$) for coronal vs. middle, ($p = 0.012$) for coronal vs. apical, and ($p = 0.075$), NS for middle vs. apical. For Group 3: (Thermafil with Ceraseal) and Group 4: (Thermafil with AH), the mean ranks were significantly different between the coronal layer and the other two section ($p < 0.05$), but not between the middle and apical section ($p > 0.05$, NS).

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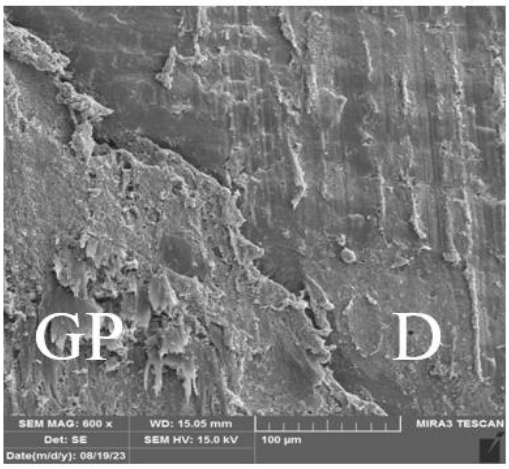

Figure (3): SEM image of GuttaCore with ceraseal sealer at coronal third at(1500X)

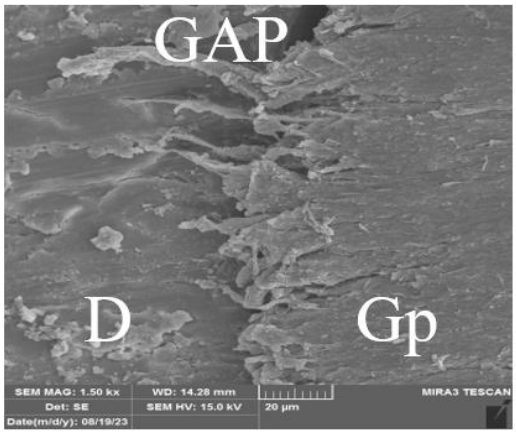

Figure (4): SEM image of GuttaCore with ceraseal sealer at apical third at(1500X)

In Group 5: (Conventional GP with Ceraseal), there were no significant differences in mean ranks between any pairs of section ($p > 0.05$, NS). Group 6: (Conventional GP with AH), in coronal section of the tooth shows very good scores (p=9.20) with significant difference comparing it to Middle and Apical section the mean ranks were significantly different between all pairs of section ($p < 0.001$). Overall, the results suggest that the combination of materials and the section of the tooth can influence the sealing ability, with some combinations exhibiting significant differences in sealing ability between the coronal, middle, and apical section of the tooth.

Discussion

The primary goal of filling a root canal is to effectively seal the entire space of the root canal from coronal, middle to apical space which is a complicated step in endodontic treatment.[19] To find the best way to clean and shape the root canal system, then fill it to create a 3-D seal coronally, laterally and apically within the root canal system is a challenging yet crucial step in endodontics.[20] Removing the smear layer is key for successful root canal treatment. That's why smear layer was removed before testing how well filling materials penetrated and adapted.[21] Thermafil (Dentsply Tulsa), a solid filling material with a metal core and gutta-percha coating, was easy to place but on the same time made post placement hard.[22] Newer versions have a plastic core (GuttaCore) and a temperature-controlled heater. These obturators were designed to conform to ISO standards, improving compatibility and ease of use.[22] Dentsply's GuttaCore, a cross-linked new version of gutta-percha without plastic core, makes post placement and retreatment easier.[23,24] In this study we compare the sealing ability of GuttaCore, Thermafill, and convevtional GP using Ceraseal and AH plus Sealer. This in vitro (SEM) analysis revealed that the thermoplastic root filling by Ceraseal sealer coated Thermafill GP with the Mean Rank (12.10) according to Table 1; which has minimal interfacial space with more gutta-percha, less sealer, and fewer empty gaps in the root canal. This might be due to Ceraseal's bioactivity, its attraction to water, and its ability to spread well. This produces the sealer to cover the canal walls, resulting in an ideal seal.[25] The mean rank (60.03) of GuttaCore in total with both sealers shows inferior results to Thermafil GP, with the better results with Ceraseal (26.77) in compare with AH plus (33.73). According to

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these findings; Althouth GuttaCore obturator is entirely made from two different gutta-percha forms; elastomer with peroxide (as an intermolecular cross links), This advanced GuttaCore carrier system with root canal sealer did not able to improve the sufficient filling of the root canal compared to Thermafil filling.[26] Ceraseal when used with GuttaCore and Thermafil GP the results were better with the mean rank (26.77 and 12.10),while for AH plus sealer with both carier- based GP mean rank was (33.73 and 20.07) subsequently. These findings could be attributed to an increasing flow of warm gutta-percha, resulting in a well-mixed bulk of gutta-percha and a small amount of sealer.[27] Recent SEM study reported that Ceraseal sealer presented a superior adaptability to the canal walls incompare to AHplus sealer.[25,28,29] Although none of the materials used regarding the gutta-percha and the resin sealers did not able to fill the root canal completely without leaving gabs. the sealing ability of Thermafil was significantly different with the Total Mean Rank (31.67) incompare to GuttaCore (60.03), and Conventional GP (44.80). In Table 2, GuttaCore shows better sealing ability with fewer gap in Coronal section when comparing to Apical and middle third. Marciano et al. confirm this in their publication and porf that many anatomical variations could influence the results of studies done with natural teeth.[30] On the same time we notice that results of AH plus with conventional GP with the mean rank (9.20) at Coronal third were significantly better than with Ceraseal sealer with the mean rank (23.47). It could be due to that with conventional Gutta-percha, the obturation of the lateral canals was attained only with sealer, on the other hand, Thermoplasticized gutta-percha techniques generally facilitate the filling of lateral canals with gutta-percha itself. Conversely, conventional gutta-percha techniques often lead to the filling of these lateral canals primarily with sealer.[31] Reducing the amount of sealer used can help minimize voids and gaps, as sealers tend to leave spaces between themselves and gutta-percha after setting.[32] While during the obturation of canal with either Thermafil or GuttaCore using AH plus sealer with their physical and chemical features were negatively affected by heat during changes in temperature.[26] Overall, carrier-based obturation systems generally demonstrated superior results compared to conventional methods. However, it is crucial to acknowledge that the clinical implications of various sealers and filling techniques should be comprehensively evaluated using multiple methods, including micro-CT, to gain a more comprehensive understanding.

Conclusion

The sealing ability of the Materials used in this study regarding the obturating cone and the resin sealers was not able to fill the root canal completely without leaving gabs.
Thermafill gutta-percha with Ceraseal sealer had a maximum area of root canal filled.

Conflict of interest

The authors recorded no conflict of interest.

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References

1. Stoll R, Betke K, Stachniss V. The influence of different factors on the survival of root canal fillings: A 10-year retrospective study. J Endod. 2005;31(11):783-90.
2. Wu MK, van der Sluis LW, Wesselink PR. The capability of two hand instrumentation techniques to remove the inner layer of dentine in oval canals. Int Endod J. 2003;36(3):218-24.
3. Sjögren U, Hägglund B, Sundqvist G, Wing K. Factors affecting the long-term

https://doi.org/10.56056/amj.2026.460


results of endodontic treatment. J Endod. 1990;16(10):498-504.
4. Basmadjian-Charles CL, Farge P, Bourgeois DM, Lebrun T. Factors influencing the long-term results of endodontic treatment: a review of the literature. Int Dent J. 2002;52(2):81-6.
5. Orstavik D. Materials used for root canal obturation: technical, biological and clinical testing. Endod Top. 2005;12(1):25-38.
6. İnan U, Aydemir H, Taşdemir T. Leakage evaluation of three different root canal obturation techniques using electrochemical evaluation and dye penetration evaluation methods. Aust Endod J. 2007;33(1):18-22.
7. Beasley RT, Williamson AE, Justman BC, Qian F. Time required to remove GuttaCore, Thermafil Plus, and thermoplasticized gutta-percha from moderately curved root canals with ProTaper Files. J Endod. 2013;39(1):125-8.
8. Li GH, Niu LN, Selem LC, Eid AA, Bergeron BE, Chen JH, et al. Quality of obturation achieved by an endodontic core-carrier system with crosslinked gutta-percha carrier in single-rooted canals. J Dent. 2014 Sep;42(9):1124-34.
9. Frajlich SR, Goldberg F, Massone EJ, Cantarini C, Artaza LP. Comparative study of retreatment of Thermafil and lateral condensation endodontic fillings. Int Endod J. 1998 Sep;31(5):354-7.
10. Zehnder M, Paqué F. Disinfection of the root canal system during root canal re-treatment. Endod Top. 2008;19(1):58-73.
11. Nagas E, Altundasar E, Serper A. The effect of master point taper on bond strength and apical sealing ability of different root canal sealers. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009;107(1): e61-4.
12. de Ingle JL, Bakaland LK, Baumgartner JC, de Ingle JL. 6th ed. Hamilton, New Delhi: Decker BC, Ingles Endodontics. 2008,112,114-120
13. Rotstein I, Ingle JI. Ingle's endodontics. 7th ed. Stamford: PMPH-USA; 2019.
14. Khayat A, Lee SJ, Torabinejad M. Human saliva penetration of coronally unsealed obturated root canals. J Endod. 1993;19(9):458-61.
15. Trope M, Chow E, Nissan R. In vitro endotoxin penetration of coronally unsealed endodontically treated teeth. Dent Traumatol. 1995;11(2):90-4.
16. Bansal R, Raghavendra S, Sujatha P, et al. Effectiveness of NaOCl and EDTA in smear layer removal. Indian J Dent Res. 2014;25(6):779-85.
17. Ghosh A, Saha S, Patra S, et al. Effect of post-filling incubation on sealing ability of different sealers: An in vitro study. Int J Endod. 2021;54(4):567-573.
18. Ray H, Seltzer S. A new glass ionomer root canal sealer. J Endod. 1991;17(12):598-603.
19. Makandar SD, Khaiser MI, Mali SR, Karobari MI, Marya A, Messina P, et al. Plywood Jig—A New Technique for Root Canal Curvature Measurement. Applied Sciences. 2021; 11(9):3999.
20. Johnson WT, Kulild JC. Obturation of the cleaned and shaped root canal system. In: Hargreaves KM, Cohen S, editors. Cohen's Pathways of the Pulp. 10th ed. St. Louis: Mosby Elsevier; 2011. p. 349-88.
21. Guerisoli DM, Marchesan MA, Walmsley AD, Lumley PJ, Pecora JD. Evaluation of smear layer removal by EDTAC and sodium hypochlorite with ultrasonic agitation. Int Endod J. 2002;35(5):418-21.
22. Bhandi SH, Subhash TS. Comparative evaluation of sealing ability of three newer root canal obturating materials guttaflow, resilon and thermafil: an in vitro study. J Int Oral Health. 2013;5(1):54-65.
23. Clark-Holke D, Drake D, Walton R, Rivera E, Guthmiller JM. Bacterial penetration through canals of endodontically

https://doi.org/10.56056/amj.2026.460


treated teeth in the presence or absence of the smear layer. J Dent. 2003;31(4):275-81.
24. Economides N, Kokorikos I, Kolokouris I, Panagiotis B, Gogos C. Comparative study of apical sealing ability of a new resin-based root canal sealer. J Endod. 2004;30(6):403-5.
25. Eltair M, Pitchika V, Hickel R, Kühnisch J, Diegritz C. Evaluation of the interface between gutta-percha and two types of sealers using scanning electron microscopy (SEM). Clin Oral Investig. 2018;22(4):1631-9.
26. Marques-Ferreira M, Abrantes M, Ferreira HD, Caramelo F, Botelho MF, Carrilho EV. Sealing efficacy of system B versus Thermafil and Guttacore obturation techniques evidenced by scintigraphic analysis. J Clin Exp Dent. 2017;9(1): e56-e60.
27. Venturi M. Evaluation of canal filling after using two warm vertical gutta-percha compaction techniques in vivo: a preliminary study. Int Endod J. 2006;39(7):538-46.
28. Candeiro GT, Correia FC, Duarte MA, Ribeiro-Siqueira DC, Gavini G. Evaluation of radiopacity, pH, release of calcium ions, and flow of a bioceramic root canal sealer. J Endod. 2012;38(6):842-5.
29. Jeong JW, DeGraft-Johnson A, Dorn SO, Di Fiore PM. Dentinal tubule penetration of a calcium silicate–based root canal sealer with different obturation methods. J Endod. 2017;43(4):633-7.
30. Marciano MA, Ordinola-Zapata R, Cunha TV, Duarte MA, Cavenago BC, Garcia RB, et al. Analysis of four gutta-percha techniques used to fill mesial root canals of mandibular molars. Int Endod J. 2011;44(4):321-9.
31. Araujo JA, Cantarini C, Han V, Goldberg F. A comparative study between the single gutta-percha cone technique and GuttaCore in the filling of simulated lateral canals. Endod Pract US. 2019;12(1):37-42.
32. Gulsahi K, Cehreli ZC, Kuraner T, Dagli FT. Sealer area associated with cold lateral condensation of gutta-percha and warm coated carrier filling systems in canals prepared with various rotary NiTi systems. Int Endod J. 2007;40(4):275-81.

https://doi.org/10.56056/amj.2026.460