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Coronal Microleakage in Endodontically Treated Teeth: A Comparative Study of Sealers and Obturation Techniques

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Abstract Endodontic treatment aims to prevent reinfection of the root canal system by achieving a hermetic seal. However, microleakage remains a challenge, potentially leading to treatment failure. This study investigated the effects of sealer type and obturation technique on coronal microleakage in endodontically treated teeth. The purpose of this study was to compare the effectiveness of two sealers (Dorifill, AH26) and two obturation techniques (lateral condensation, warm gutta-percha) in preventing coronal microleakage. A total of 192 extracted human teeth were used in the study. Teeth were prepared and obturated, then stored in natural saliva for varying durations. Microleakage was assessed using dye penetration and measured under a microscope. The teeth were divided into four experimental groups based on storage time (1, 3, 7, or 30 days) and further into subgroups based on sealer and obturation technique. Canals were obturated with gutta-percha and either Dorifill or AH26 sealer, using lateral condensation or warm gutta-percha techniques. Obturated teeth were stored in natural saliva at 37°C for the designated experimental periods. All groups exhibited some degree of microleakage. Lateral condensation with AH26 consistently showed the highest leakage, while Dorifill and warm gutta-percha demonstrated better sealing ability. Microleakage increased with longer storage times for most groups. Lateral condensation with AH26 showed the highest mean leakage value at all time points (3.178mm at 1 day, 4.59mm at 3 days, 4.025mm at 7 days, and 4.12mm at 30 days). Dorifill and warm gutta-percha showed lower leakage values compared to AH26. ANOVA and LSD tests revealed significant differences between groups and time points. The study emphasizes the importance of sealer selection and obturation technique in reducing coronal microleakage, with sealer choice being a more critical factor. The mixture of Dorifill and warm gutta-percha appears promising. Further investigate is needed to validate these conclusions and improve long-term endodontic success

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Keywords: *obturation technique, endodontically treated teeth,sealer type,Dorifill, AH26, lateral condensation, warm gutta-percha, Coronal microleakage*

1. INTRODUCTION

Endodontics, a pivotal branch of dentistry, emphasis on the intricate morphology, physiology, and pathology of the human dental pulp and periradicular tissues. The cornerstone of prosperous endodontic treatment lies in the practitioner's capability to thoroughly eliminate the contents of the root canal system and after achieve a three-dimensional obturation of this space, ensure a hermetic seal . This meticulous process aims to inhibit the reinfection of the canal system, thereby maintaining the tooth's functionality and structural integrity (1).

However, the persistent challenge of microleakage in endodontically processed teeth can undermine the success of even the most meticulously completed procedures. Microleakage, in the endodontic context, mention to the insidious seepage of fluids, bacteria, and detrimental materials into the periapical region. This percolation can instigate a cascade of clinical complications, including persistent inflammation, superinfection, and ultimately, treatment failure (2).

The ramifications of microleakage extend beyond the instant periapical area. Postoperative events, such as trauma, fractures, periodontal participation, and inadequate or absent final restorations, can exacerbate the risk of both direct and oblique treatment failure. A well-executed coronal restoration plays a dual role in this scenario: it fortifies the tooth structure and serves as a barrier opposing coronal microleakage. This defensive function is of paramount importance, as it thwarts the apical dispersion of bacteria and saliva, which could otherwise compromise the treatment outcome (3).

While apical microleakage has conventionally been regarded as a principal determinant of endodontic success, the importance of coronal microleakage is increasingly recognized.

This shift in perspective is driven by the understanding that even with perfect apical sealing, the presence of coronal leakage can serve as a conduit for microbial ingress and reinfection. Accordingly, the focus has expanded to encompass the entirety of the root canal system, highlighting the need for a comprehensive sealing strategy that addresses both apical and coronal vulnerabilities (4).

The complex nature of root canal anatomy, with its fins, lateral canals, and cul-de-sacs, necessitates a meticulous approach to obturation. Achievement a seal that extends as close as possible to the cementodentinal junction is crucial for avoiding the ingress of irritants and minimizing the risk of periapical inflammation. However, even with optimum obturation, restorative errors or complications, such as post-induced perforations or fractures, can jeopardize the therapy outcome (5).

The long-term consequences of microleakage are especially concerning. Over extended periods, even a well-condensed and adapted obturation can be endangered by the disruption or dissolution of the sealer at the gutta-percha interface or the sealer-dentinal wall interact. This gradual breakdown of the seal can facilitate the egress of microorganisms or toxins from the apex, triggering or exacerbating bitewing x-ray disease and ultimately leading to treatment failure (6).

By clarifying the complex interplay of these variables, this study seeks to provide valuable insights into the optimisation of endodontic procedures and the mitigation of coronal microleakage.

2. MATERIALS AND METHODS Sample Selection

One hundred and ninety-two extracted human teethfreshly with single root canals and mature apices were used in this study. The age, sex, pulpal status, and reason for extraction were not recorded. Criteria for selection included the following:

1. Single canal root.
2. Completely formed apex.
3. A patent foramen.
4. Apical foramen size 20, 25 (first file that binds to the working length)
5. Roots without cracks or fractures.

Sample Preparation:

One hundred and ninety-two freshly extracted human teeth with single root canals and mature apices were used. Teeth were stored in normal saline at room temperature, and those with visible cracks or fractures were discarded. Crowns were sectioned 2 mm coronal to the cementoenamel junction (CEJ) to standardize access preparation. After pulp removal, canals were instrumented using the step-back technique to a size #40 master apical file, followed by Gates-Glidden drills for coronal flaring. Canals were irrigated with 2.5% NaOCl and dried with paper points.

Sample grouping

The teeth were randomly divided into four experimental groups, each group was divided into four subgroups (n=12), with one positive and one negative control for each. Groups were based on storage time in natural saliva: 1 day, 3 days, 7 days, or 30 days. Subgroups were based on sealer (Dorifill or AH26) and obturation technique (lateral condensation or warm gutta-percha).

Preparation of the acrylic socket simulator

To simulate the periodontal ligament and create a standardized socket, roots were wrapped in lead foil, embedded in acrylic resin, and then removed. Silicone impression material was injected into the resulting space in the acrylic mold, and the root was repositioned that is done according to (7). This created a 0.15mm thick silicone layer surrounding the root, mimicking the periodontal ligament.

Canal obturation and storage

Canal obturation and storage: Canals were obturated with gutta-percha and either Dorifill or AH26 sealer, using lateral condensation or warm gutta-percha techniques. Obturated teeth were radiographed, sealed with temporary restorations, and stored in natural saliva at 37°C for 5 days to allow sealer setting. After setting, temporary restorations were removed, and samples were stored in natural saliva at 37°C for the designated experimental periods (1, 3, 7, or 30 days) that is done according to (8).

Thermocycling

After aging, samples were thermocycled in 2% methylene blue dye for 10, 30, 70, or 300 cycles (corresponding to 1, 3, 7, or 30 days of storage) using a thermocycler with 5°C and 55°C baths and a 30-second dwell time.

Data collection

After thermocycling, specimens were dried, sticky wax removed, and longitudinally sectioned. Dye penetration was measured under a microscope at x4 magnification, from the coronal end of the obturation to the furthest extent of dye penetration. Two readings were taken from each tooth by two independent evaluators, and the average was used for statistical analysis.

Statistical analysis

Data were collected and analyzed using SPSS version 10.0 for Windows (SPSS, Chicago, Illinois, and USA). Differences between groups were examined by ANOVA (Analysis of variance of mean). Special t-test (LSD) was done to detect the significance of differences between every two groups. P.value < 0.05 was considered as statistically significant.

3. RESULTS

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Under the conditions of the present study, all experimental groups demonstrated varying degrees of dye penetration alongside the canal space and in the dentinal tubules. The positive controls of all experimental groups revealed complete dye penetration, while no dye leakage was observed in any of the negative controls.

At one day of storage in natural saliva, lateral condensation technique using AH26 scored the highest mean leakage value which was 3.178mm, then followed by warm gutta-percha with AH26 which showed 2.0mm mean leakage value. Lateral condensation with Dorifill and warm gutta-percha with Dorifill scored 1.64mm and 1.61mm respectively. Both values were close to each other. ANOVA test showed highly significant differences (P<0.001) between the four tested groups at one-day storage groups in natural saliva.

At three-day storage groups, lateral condensation technique with AH26 scored the highest mean leakage value which was 4.59mm, followed by warm gutta-percha technique with AH26 which scored 4.22mm mean leakage value. While both lateral condensation technique with Dorifill and warm gutta-percha with Dorifill showed nearly the same value of linear microleakage which was 2.94mm and 2.72mm respectively. ANOVA test also showed highly significant differences (P<0.001) between the four tested groups at three-day storage in natural saliva.

At seven-day storage groups, lateral condensation technique with Dorifill showed the highest mean leakage which was (4.0625mm) followed by lateral condensation technique with AH26 (4.025mm), then warm gutta-percha technique with AH26 and warm gutta-percha with Dorifill which scored a mean leakage values equal to (3.1mm) and (2.5mm) respectively. ANOVA test showed highly significant differences (P=0.006) between the groups tested at seven-day storage in natural saliva.

One-month storage in natural saliva showed high mean values for all tested groups. Lateral condensation technique with AH26 scored the highest mean leakage value (4.12mm), while lateral condensation technique with Dorifill showed the least mean value of leakage which was 2.44mm. ANOVA test showed a statistically significant difference (P<0.031) between the different tested groups regarding one-month storage in natural saliva.

In order to statistically verify the significance within the different groups, a least significant difference test (LSD) was performed to compare pairs of mean microleakage values of the different groups. The highly significant different groups are connected by horizontal lines connecting the statistically different values, between each group and another, other horizontal lines are also connecting the groups that exhibited non significant differences. These horizontal lines represented the non significant differences between different groups at each storage period.

For more statistical information and details, each tested group was statistically analyzed regarding different time intervals within the same group. ANOVA test showed highly significant differences between groups (P<0.001) except for lateral condensation technique accompanied by AH26 sealer which showed non significant differences regarding different time intervals.

Finally, in order to statistically verify the significance within the different groups regarding different time intervals, a Least Significant Difference test (LSD) was performed to compare pairs of mean microleakage values of the different time intervals for each tested group. The results of the comparisons are listed in LSD where the horizontal lines connecting the statistically different values. The horizontal lines connected each specific group who exhibited highly significant differences, significant, non significant differences regarding different storage periods. For example, for the lateral condensation and Dorifill a highly significant difference was recorded between one day and three days of storage in natural saliva, while a non significant difference was recorded between one day and one month for that specific group.

Table 1 Mean microleakage values (mm) and ANOVA results by group and time point.

Group	Time Point (Days)	Mean Leakage (mm)	Standard Deviation	ANOVA (P-value)
Lateral Condensation + Dorifill	**1**	1.64	0.878	**<0.001**
Lateral Condensation + Dorifill	**3**	2.94	1.134	**<0.001**
Lateral Condensation + Dorifill	**7**	4.063	1.028	**0.006**
Lateral Condensation + Dorifill	**30**	2.44	1.023	**<0.031**
Warm Gutta-Percha + Dorifill	**1**	1.61	0.899	**<0.001**

Warm Gutta-Percha + Dorifill	**3**	2.72	1.183	**<0.001**
Warm Gutta-Percha + Dorifill	**7**	2.5	1.291	**0.006**
Warm Gutta-Percha + Dorifill	**30**	3.5	1.604	**<0.031**
Lateral Condensation + AH26	**1**	3.178	0.622	**<0.001**
Lateral Condensation + AH26	**3**	4.59	0.707	**<0.001**
Lateral Condensation + AH26	**7**	4.025	1.035	**0.006**
Lateral Condensation + AH26	**30**	4.12	0.901	**<0.031**
Warm Gutta-Percha + AH26	**1**	2	0.756	**<0.001**
Warm Gutta-Percha + AH26	**3**	4.22	0.958	**<0.001**
Warm Gutta-Percha + AH26	**7**	3.1	1.14	**0.006**
Warm Gutta-Percha + AH26	**30**	3.94	0.964	**<0.031**

4. DISCUSSION

This study aimed to evaluate the impact of two sealers (Dorifill and AH26) and two obturation techniques (lateral condensation and warm gutta-percha) on coronal microleakage in endodontically treated teeth over various storage periods in natural saliva. Our results indicate that all experimental groups, regardless of the specific combination of sealer and technique, exhibited measurable dye penetration. This observation underscores the ongoing challenge of achieving complete hermetic sealing in endodontic treatments, even under controlled experimental conditions.

Lateral condensation with AH26 consistently demonstrated the highest mean leakage values across all time points. This outcome aligns with previous studies that have reported higher microleakage rates related with AH26, a resin-based sealer that experiences polymerization shrinkage (9,10) . The volumetric changes during setting might produce gaps or channels at the sealer-dentin interface, facilitating the ingress of fluids and bacteria.

In contrast, Dorifill, a resin-based sealer with improved flow and adaptation properties, exhibited generally lower leakage values compared to AH26. This comment is consistent with studies that have emphasized Dorifill's favorable sealing ability due to its excellent physical-chemical properties and biocompatibility (11,12). The superior performance of Dorifill might be assigned to its ability to penetrate and seal dentinal tubules effectively, minimizing the possibility for microleakage.

The warm gutta-percha technique, particularly when mixed with Dorifill, demonstrated lower microleakage compared to lateral compression. This finding corroborates the results of past studies that have reported improved adaptation and sealing ability with warm obturation techniques (13,14). The enhanced flow and plasticity of warm gutta-percha allow for better adaptation to the root canal anatomy, potentially reducing voids and enhancing the overall seal.

The observed increase in microleakage with longer storage periods for most groups, except for lateral condensation with AH26, suggests a time-dependent degradation of the sealer-dentin interface. This phenomenon might be attributed to the gradual hydrolysis and breakdown of sealer components, leading to the formation of micro-gaps and channels that facilitate dye penetration (15). Interestingly, the stable leakage values observed with lateral condensation and AH26 over time might be due to the initial high leakage, which could have masked any further increases (16).

Our findings highlight the multifactorial nature of coronal microleakage, with both sealer selection and obturation technique playing significant roles. While the choice of sealer appears to be a more critical determinant of sealing effectiveness, the obturation technique also contributes to the overall outcome. The combination of Dorifill and warm gutta-percha seems to offer a promising approach to minimize coronal microleakage, potentially improving the long-term success of endodontic treatments.

5. CONCLUSIONS

The study underscores the persistent challenge of achieving complete hermetic sealing in endodontic treatments. Coronal microleakage is influenced by both sealer selection and obturation technique. While sealer choice is a more critical determinant, the obturation technique also plays a role. The combination of Dorifill and warm gutta-percha appears promising for minimizing coronal microleakage. Further research is needed to validate these findings and explore additional strategies for enhancing the long-term success of endodontic treatments.

DECLARATIONS

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

AUTHORS’ CONTRIBUTION

All authors listed have made a significant, direct, intellectual contribution to the work and approved it for publication.

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Noun.

DATA AVAILABILITY

All datasets generated or analyzed during this study are included in the manuscript.

REFERENCES

[1] Albuquerque, D., Kottoor, J., & Hammo, M. (2014). Endodontic and clinical considerations in the management of variable anatomy in mandibular premolars: A literature review. *Biomed Research International*, *2014*, 512574. https://doi.org/10.1155/2014/512574

[2] Mostafavi, A. S., Rasoulzadehsheikh, M., Meraji, N., & Pourhajibagher, M. (2022). Bacterial microleakage in endodontically treated teeth following two methods of post space preparation at two-time intervals: An in vitro study. *Journal of Indian Prosthodontic Society, 22*, 233–239.

[3] Paulo, S., Abrantes, A. M., Xavier, M., Brito, A. F., Teixo, R., Coelho, A. S., et al. (2023). Microleakage evaluation of temporary restorations used in endodontic treatment—An ex vivo study. *Journal of Functional Biomaterials, 14*. https://doi.org/10.3390/jfb14050264

[4] Sritharan, A. (2002). Discuss that the coronal seal is more important than the apical seal for endodontic success. *Australian Endodontic Journal, 28*, 112–115.

[5] Lee, M.-H., Ha, J.-H., Jin, M.-U., Kim, Y.-K., & Kim, S.-K. (2013). Endodontic treatment of maxillary lateral incisors with anatomical variations. *Restorative Dentistry and Endodontics, 38*, 253–257.

[6] Jafari, F., & Jafari, S. (2017). Importance and methodologies of endodontic microleakage studies: A systematic review. *Journal of Clinical and Experimental Dentistry, 9*, e812–e819.

[7] Rathi, A., Chowdhry, P., Kaushik, M., Reddy, P., Roshni, & Mehra, N. (2018). Effect of different periodontal ligament simulating materials on the incidence of dentinal cracks during root canal preparation. *Journal of Dental Research, Dental Clinics, Dental Prospects, 12*, 196–200.

[8] Safai, P., Farzaneh, B., & Fekrazad, R. (2019). The effects of pressure in vitro on three methods of root canal obturation. *Diving and Hyperbaric Medicine, 49*, 16–20.

[9] Gerdolle, D. A., Mortier, E., & Droz, D. (2008). Microleakage and polymerization shrinkage of various polymer restorative materials. *Journal of Dentistry for Children, 75*, 125–133.

[10] Vula, V., Stavileci, M., Ajeti, N., Vula, V., Kuçi, A., & Meqa, K. (2022). Evaluation of apical leakage after root canal obturation with glass ionomer, resin, and zinc oxide eugenol sealers combined with Thermafil. *Medical Science Monitor Basic Research, 28*, e936675.

[11] Forough Reyhani, M., Ghasemi, N., Rahimi, S., Milani, A. S., & Omrani, E. (2016). Effect of different endodontic sealers on the push-out bond strength of fiber posts. *Iranian Endodontic Journal, 11*, 119–123.

[12] Madhuri, G. V., Varri, S., Bolla, N., Mandava, P., Akkala, L. S., & Shaik, J. (2016). Comparison of bond strength of different endodontic sealers to root dentin: An in vitro push-out test. *Journal of Conservative Dentistry, 19*, 461–464.

[13] Keles, A., Ahmetoglu, F., Ocak, M. S., Dayi, B., Bozkurt, A., & Orucoglu, H. (2014). Comparative analysis of three different filling techniques and the effects of experimental internal resorptive cavities on apical microleakage. *European Journal of Dentistry, 8*, 32–37.

[14] Pinto, J. C., Pivoto-João, M. M. B., Guerreiro-Tanomaru, J. M., Reyes-Carmona, J. F., & Tanomaru-Filho, M. (2023). Continuous wave of condensation improves the filling of curved canals: A micro-CT study. *Odovtos - International Journal of Dental Sciences, 25*(1), 305–315.

[15] Ehsani, M., Dehghani, A., Abesi, F., Khafri, S., & Ghadiri Dehkordi, S. (2014). Evaluation of apical micro-leakage of different endodontic sealers in the presence and absence of moisture. *Journal of Dental Research, Dental Clinics, Dental Prospects, 8*, 125–129.

[16] Samadi, F., Jaiswal, J., Saha, S., Garg, N., Chowdhary, S., & Samadi, F. (2014). A comparative evaluation of efficacy of different obturation techniques used in root canal treatment of anterior teeth: An in vitro study. *International Journal of Clinical Pediatric Dentistry, 7*, 1–5.

[17] Obaid, D. H., Hadi, R. J., Hassan, A. F. A., & Al-Taai, N. (2024). Herbal extract and white spot lesion: A review. *Journal Port Science Research, 7*(1), 1–5.

[18] Al-Azzawi, N. N., Hussein, M. K., & Khalaf, M. I. (2024). Verification of the association between IL6-174 G/C polymorphism in type 2 diabetes mellitus. *Journal Port Science Research, 7*(1), 36–42.

[19] Al-Shukry, A. H., Mansor, Z. E., & Abd Al-Hussein, N. A. (2024). Spectrophotometric determination of uric acid in samples of urine. *Journal Port Science Research, 7*(1), 22–29.

[20] Al-Jeboory, A. W., & Farid, Y. Y. (2021). Natural product chemistry research in Iraq. *Journal Port Science Research, 4*(1), 41–45.

[21] Al-Jawher, W. A. M., & Shaban, S. A. A. (2022). Clustering of medical images using multiwavelet transform and K-means algorithm. *Journal Port Science Research, 5*(1), 35–42.