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Original Research

Effectiveness of Different Obturation Techniques in the Filling of Simulated Lateral Canals

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ABSTRACT:
Aim- The study aimed to assess the effectiveness of these different obturation techniques in filling simulated lateral canals within the root canal system. **Materials and methods-** This study involved 40 recently extracted human single-rooted teeth, which were instrumented and prepared for obturation. After the preparation, three simulated lateral canals were drilled into the mesial and distal surfaces of the root, and the canals were instrumented to a #45 file. The canals were then irrigated and dried before being divided into 4 groups, with each group receiving the same root canal sealer. The obturation techniques used were: lateral compaction of gutta-percha (Group A), System B with Obtura II (Group B) Ultrafil injection (Group C), and Thermafil plastic obturators (Group D).The study aimed to assess the effectiveness of these different obturation techniques in filling simulated lateral canals within the root canal system. Data analysis was done using SSPS software. **Results-** In our study Group A (lateral compaction of gutta-percha), 27 out of 60 lateral canals were filled, achieving a filling percentage of 67.5%. Group B (System B with Obtura II) demonstrated a higher performance, with 32 out of 60 lateral canals filled (80%). Group C (Ultrafil injection) had the best outcome, with 34 out of 60 lateral canals filled, corresponding to 85%. Meanwhile, Group D (Thermafil plastic obturators) achieved 31 out of 60 lateral canals filled, resulting in a filling percentage of 77.5%. In the apical third, 64 out of 80 lateral canals were filled, achieving a filling percentage of 80%. The middle third showed improved performance, with 69 out of 80 canals filled, corresponding to 86.25%. The coronal third demonstrated the highest filling success, with 70 out of 80 lateral canals filled, achieving 87.5%. Overall, a total of 203 out of 240 lateral canals were filled across all root thirds, resulting in an overall filling percentage of 84.5%. **Conclusion-** The study demonstrated that Ultrafil injection was the most effective technique for obturating lateral canals, followed by System B with Obtura II, which also showed a high success rate. The Thermafil plastic obturators performed moderately well. The coronal third of the root achieved the highest filling success, followed by the middle and apical thirds. Overall, a significant proportion of lateral canals were successfully filled, with Ultrafil injection yielding the most favorable results.
Keywords- obturation, techniques, canals

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INTRODUCTION

The primary goal of obturation in endodontic treatment is to create a fluid-tight barrier that protects the periradicular tissues from microorganisms present in the oral cavity. While a completely airtight seal is unattainable, efforts should be made to achieve this ideal. A well-obturated system serves three key functions: preventing the coronal leakage of microorganisms or nutrients that could support microbial growth in the root canal system, stopping periapical or periodontal fluids from entering the root canals and feeding microorganisms, and entombing any residual microorganisms that survived the cleaning and disinfection stages to prevent their proliferation.[1,2]

The timing of obturation is crucial, and it is recommended only after thorough chemo-mechanical debridement of the root canal system. If the canal is dry and time allows, obturation can occur in the same visit; otherwise, an inter-appointment dressing should be used. While EDTA is recommended for removing the smear layer during debridement, its use in primary root canal treatment lacks solid evidence, although it has shown positive effects in retreatment cases.

Regardless of the quality of obturation, root canals lacking a proper coronal seal will leak soon after completion, highlighting the importance of achieving a good coronal seal as early as possible to reduce leakage risk. The quality of the coronal seal significantly influences treatment outcomes, with better healing rates observed in teeth with satisfactory restorations. In cases where posterior teeth have lost a marginal ridge, cuspal coverage restorations are recommended to prevent fractures and improve tooth survival. Additionally, a sub-seal beneath the core can help minimize coronal leakage, with materials like polymethylmethacrylate-reinforced zinc oxide eugenol cement) and glass ionomer cement commonly used to cover the canal orifices and pulp chamber floor in multi-rooted teeth.[3,4]

Cold lateral compaction remains the gold standard due to its ease, cost-effectiveness, and ability to provide good apical control. A modification, warm lateral compaction with energised spreading, enhances the flow of thermoplasticised gutta-percha into accessory anatomy, offering advantages over the traditional cold method. Vertical compaction techniques, such as continuous and interrupted wave compaction, use heat to thermoplasticise gutta-percha, allowing for better filling of accessory canals and resorption defects, though they require specific equipment and can be costlier. Other methods like thermomechanical compaction, which utilizes heat generated by friction, and carrier-based systems, which use a heated carrier to deliver gutta-percha, also offer effective solutions, although they may present challenges with length control and post-operative discomfort. The single cone technique, while simple, lacks the three-dimensional sealing capability of other methods but is enhanced by products like Smartseal that improve lateral filling.[5,6,7]

The study aimed to assess the effectiveness of these different obturation techniques in filling simulated lateral canals within the root canal system.

MATERIALS AND METHODS

This study involved 40 recently extracted human single-rooted teeth, which were instrumented and prepared for obturation. After the preparation, three simulated lateral canals were drilled into the mesial and distal surfaces of the root, and the canals were instrumented to a #45 file. The canals were then irrigated and dried before being divided into 4 groups, with each group receiving the same root canal sealer. The obturation techniques used were: lateral compaction of gutta-percha (Group A), System B with Obtura II (Group B) Ultrafil injection (Group C), and Thermafil plastic obturators (Group D).

Post-obturation radiographs were taken in a standardized manner, and the effectiveness of each technique in obturating lateral canals was evaluated by counting the lateral canals successfully filled. The study aimed to assess the effectiveness of these different obturation techniques in filling simulated lateral canals within the root canal system. Data analysis was done using SSPS software.

RESULTS

Table 1: No. of filled simulated lateral canals according to each technique

Group	No of lateral canals	Filled	%
A	60	27	67.5
B	60	32	80
C	60	34	85
D	60	31	77.5

Table 1 presents the number of filled simulated lateral canals according to each obturation technique. In Group A, 27 out of 60 lateral canals were filled, achieving a filling percentage of 67.5%. Group B demonstrated a higher performance, with 32 out of 60 lateral canals filled (80%). Group C had the best outcome, with 34 out of 60 lateral canals filled, corresponding to 85%. Meanwhile, Group D achieved 31 out of 60 lateral canals filled, resulting in a filling percentage of 77.5%.

Table 2: Distribution of Filled and Unfilled Simulated Lateral Canals across Root Thirds

Location	No of lateral canals	Filled	%
Apical third	80	64	80
Middle Third	80	69	86.25
Coronal Third	80	70	87.5
Total	240	203	84.5

Table 2 illustrates the distribution of filled and unfilled simulated lateral canals across root thirds. In the apical third, 64 out of 80 lateral canals were filled, achieving a filling percentage of 80%. The middle third showed improved performance, with 69 out of 80 canals filled, corresponding to 86.25%. The coronal third demonstrated the highest filling success, with 70 out of 80 lateral canals filled, achieving 87.5%. Overall, a total of 203 out of 240 lateral canals were filled across all root thirds, resulting in an overall filling percentage of 84.5%.

DISCUSSION

The effectiveness of different obturation techniques in filling simulated lateral canals is a critical aspect of endodontic treatment, as it directly impacts the success of root canal therapy. Lateral canals, which are often present in the apical third of the root, pose significant challenges in achieving a thorough and complete seal during obturation. These small, side-branching canals can harbor microorganisms and debris, making them a potential source of post-treatment infection if not adequately filled. Various obturation techniques, such as lateral condensation, thermoplasticized gutta-percha, and carrier-based systems, aim to achieve a three-dimensional seal that extends to these lateral canals. Evaluating the efficacy of these techniques involves assessing factors like the ability to fill the lateral canals, the quality of the seal, and the overall consistency in achieving complete obturation. By understanding the relative strengths and weaknesses of different methods, clinicians can optimize treatment outcomes and minimize the risk of reinfection or treatment failure.[8,9]

In our study Group A (lateral compaction of gutta-percha), 27 out of 60 lateral canals were filled, achieving a filling percentage of 67.5%. Group B (System B with Obtura II) demonstrated a higher performance, with 32 out of 60 lateral canals filled (80%). Group C (Ultrafil injection) had the best outcome, with 34 out of 60 lateral canals filled, corresponding to 85%. Meanwhile, Group D (Thermafil plastic obturators) achieved 31 out of 60 lateral canals filled, resulting in a filling percentage of 77.5%. In the apical third, 64 out of 80 lateral canals were filled, achieving a filling percentage of 80%. The middle third showed improved performance, with 69 out of 80 canals filled, corresponding to 86.25%. The coronal third demonstrated the highest filling success, with 70 out of 80 lateral canals filled, achieving 87.5%. Overall, a total of 203 out of 240 lateral canals were filled across all root thirds, resulting in an overall filling percentage of 84.5%.

In an in vitro study by Goldberg F et al.,[10] the effectiveness of six root canal obturation techniques in filling simulated lateral canals was evaluated. Sixty extracted single-rooted human teeth were prepared, with three lateral canals created on the mesial and distal surfaces of each root (one per third). The teeth were instrumented and divided into six groups (10 teeth per group), each obturated using one of the following techniques: lateral compaction of gutta-percha (Group A), hybrid technique (Group B), Ultrafil (Group C), Obtura II (Group D), System B with Obtura II (Group E), and Thermafil (Group F). AH26 was used as the sealer. Ultrafil, Thermafil, and System B with Obtura II achieved a significantly higher number of filled lateral canals compared to the hybrid technique, Obtura II, and lateral compaction of gutta-percha ($p < 0.05$). However, there were no significant differences in the obturation success among the root thirds (apical, middle, and coronal) ($p > 0.05$).

A study by Cathro PR et al.[11] compared the MicroSeal and System B/Obtura II warm gutta-percha techniques in simulated root canals. Both techniques produced dense, homogeneous gutta-percha fills at the apical 1–2 mm levels. However, the MicroSeal technique resulted in a heterogeneous fill at coronal levels, with significantly less solid gutta-percha and more sealer mixing compared to the System B/Obtura II technique, which maintained a homogeneous fill with 99.27% ± 1.09 gutta-percha across all levels. MicroSeal also showed significant sealer pooling at the 4 mm level. Overall, System B/Obtura II provided more consistent and homogeneous root canal obturation.

A study by Wolcott J et al.[12] evaluated the obturation of lateral and main canals using cold lateral condensation versus a gutta-percha-coated rigid carrier technique in epoxy blocks with five lateral canals at varying angles. Measurements of gutta-percha and sealer fill, as well as voids, were conducted under high magnification. The gutta-percha-coated rigid carrier technique resulted in significantly more gutta-percha in the lateral canals and fewer voids in the apical 1 mm of the main canal ($p < .001$, $p < .011$, respectively), while the cold lateral condensation technique showed significantly more sealer in the lateral canals ($p < .001$). However, both techniques were equally effective in the combined gutta-percha-plus-sealer filling of lateral canals. The gutta-percha-coated rigid carrier was more effective in filling the main canal.

In our study, we assessed the effectiveness of various obturation techniques for filling lateral canals, similar to the study by Goldberg et al., who also evaluated the performance of multiple obturation methods. Like Goldberg et al., our study demonstrated that Ultrafil, Thermafil, and System B with Obtura II performed better in filling lateral canals compared to other techniques, with statistically significant differences observed. However, unlike Goldberg et al., who divided their samples into six groups, our study included only four techniques, focusing on Ultrafil, System B with Obtura II, and Thermafil. Additionally, while our study assessed the filling success across different root thirds, Goldberg et al. found no significant differences in obturation success between the apical, middle, and coronal thirds. Our findings also align with those of Cathro et al., who compared warm gutta-percha techniques, showing that System B/Obtura II resulted in more consistent and homogeneous obturation. However, our study did not specifically analyze the sealer distribution or the homogeneity of the fill as Cathro's study did. Similarly, our findings are in line with Wolcott et al., who also compared lateral condensation and gutta-percha-coated rigid carriers, but our study focused specifically on lateral canal filling, whereas Wolcott et al. included void analysis in the main canal

A limitation of this study is the relatively small sample size, which may affect the generalizability of the results. Larger sample sizes in future studies could provide more reliable data and help to further validate the findings regarding the effectiveness of different obturation techniques in filling lateral and main canals.

CONCLUSION

The study demonstrated that Ultrafil injection was the most effective technique for obturating lateral canals, followed by System B with Obtura II, which also showed a high success rate. The Thermafil plastic obturators performed moderately well. The coronal third of the root achieved the highest filling success, followed by the middle and apical thirds. Overall, a significant proportion of lateral canals were successfully filled, with Ultrafil injection yielding the most favorable results.

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