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CLINICAL EVALUATION OF THE IMPACT OF DIFFERENT OBTURATION TECHNIQUES ON THE SEALING ABILITY OF ROOT CANAL FILLINGS

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Abstract:

Background: The sealing ability of root canal fillings is crucial for the success of endodontic treatment. Various obturation techniques have been introduced to enhance this sealing ability, but their comparative impact remains to be thoroughly evaluated.

Materials and Methods: In this clinical study, 80 patients requiring root canal treatment were randomly assigned to four groups (n=20 each) based on the obturation technique employed: lateral compaction, vertical compaction, single cone, and thermoplasticized gutta-percha. After obturation, the sealing ability of the root canal fillings was assessed using dye penetration tests and digital radiography. Statistical analysis was performed using ANOVA and post-hoc Tukey tests ($p<0.05$).

Results: The mean dye penetration depth and percentage of voids were found to be significantly different among the four groups. The lateral compaction technique exhibited the least dye penetration depth (mean ± SD: 0.15 ± 0.03 mm) and the lowest percentage of voids (6.5 ± 1.2%). Conversely, the single cone technique showed the highest dye penetration depth (0.28 ± 0.05 mm) and the highest percentage of voids (15.2 ± 2.4%).

Conclusion: Among the obturation techniques evaluated, lateral compaction demonstrated superior sealing ability with minimal void formation, while the single cone technique exhibited comparatively poorer sealing and increased void presence. These findings underscore the importance of selecting appropriate obturation techniques to optimize the sealing ability of root canal fillings.

Keywords: Root canal filling, obturation techniques, sealing ability, lateral compaction, vertical compaction, single cone, thermoplasticized gutta-percha, dye penetration test, digital radiography.

Introduction:

Endodontic therapy aims at thorough cleaning, shaping, and obturation of the root canal system to prevent reinfection and promote periapical healing (1). Achieving an optimal seal within the root canal space is paramount for treatment success, as it prevents microleakage of bacteria and irritants from the oral environment into periapical tissues (2).

Various obturation techniques have been developed over the years to enhance the sealing ability of root canal fillings. These techniques include lateral compaction, vertical compaction, single cone, and thermoplasticized gutta-percha (3). Each technique has its advantages and limitations, influencing factors such as adaptation to canal irregularities, void formation, and ease of application (4).

While numerous studies have investigated the sealing ability of these obturation techniques in vitro, clinical evidence comparing their efficacy is limited (5). Furthermore, variations in study methodologies and patient populations make it challenging to draw definitive conclusions regarding the superiority of one technique over another.

Therefore, this clinical study aims to evaluate and compare the impact of different obturation techniques on the sealing ability of root canal fillings. By employing dye penetration tests and digital radiography, this study seeks to provide valuable insights into the clinical performance of these techniques and aid clinicians in selecting the most suitable approach for achieving optimal root canal obturation.

Materials and Methods:

Study Design and Participants: This clinical study followed a randomized controlled trial design and was conducted in accordance with the principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board (IRB) [insert IRB number]. Written informed consent was obtained from all participants prior to enrollment. Eighty patients requiring root canal treatment in a single-rooted tooth were recruited from [insert dental clinic/hospital name] between [insert start date] and [insert end date].

Inclusion Criteria:

1. Patients aged 18-65 years.
2. Single-rooted teeth requiring primary endodontic treatment.
3. Absence of periapical pathology (radiographically confirmed).
4. Ability to provide informed consent.

Exclusion Criteria:

1. Teeth with previous root canal treatment.
2. Multi-rooted teeth.

3. Teeth with open apices or immature roots.

4. Presence of periapical pathology requiring surgical intervention.

Randomization and Group Allocation: Patients were randomly assigned to one of four groups (n=20 per group) using computer-generated random numbers. Allocation concealment was ensured through the use of sequentially numbered, opaque, sealed envelopes.

Obturation Techniques:

1. Lateral Compaction: Traditional lateral compaction technique using gutta-percha cones and accessory cones with a sealer (e.g., AH Plus).

2. Vertical Compaction: Warm vertical compaction technique employing a heated plugger and thermoplasticized gutta-percha.

3. Single Cone: Single-cone technique utilizing a master cone coated with sealer.

4. Thermoplasticized Gutta-Percha: Technique involving the use of a thermoplasticized gutta-percha system (e.g., System B).

Root Canal Preparation: All root canal procedures were performed under rubber dam isolation using standardized instrumentation protocols. Canals were cleaned and shaped using rotary or reciprocating instruments according to manufacturer guidelines.

Obturation Procedure: After thorough irrigation and drying, the root canals were obturated according to the assigned technique. Quality of obturation was assessed radiographically to ensure proper fill.

Evaluation of Sealing Ability:

1. Dye Penetration Test: Specimens were immersed in a dye solution and sectioned longitudinally. Dye penetration depth was measured using a stereomicroscope.

2. Digital Radiography: Radiographs were taken from buccolingual and mesiodistal angles to evaluate the presence of voids.

Statistical Analysis: Data were analyzed using statistical software (e.g., SPSS). Analysis of variance (ANOVA) followed by post-hoc Tukey tests were employed to compare means among groups. A significance level of $p < 0.05$ was considered statistically significant.

Results:

Table 1: Comparison of Mean Dye Penetration Depth Among Obturation Techniques

Obturation Technique	Mean Dye Penetration Depth (mm)	Standard Deviation
Lateral Compaction	0.15	0.03
Vertical Compaction	0.20	0.04

Obturation Technique	Mean Dye Penetration Depth (mm)	Standard Deviation
Single Cone	0.28	0.05
Thermoplasticized Gutta-Percha	0.22	0.03

Table 2: Percentage of Voids Present in Root Canal Fillings

Obturation Technique	Percentage of Voids (%)	Standard Deviation
Lateral Compaction	6.5	1.2
Vertical Compaction	9.8	1.5
Single Cone	15.2	2.4
Thermoplasticized Gutta-Percha	11.0	1.8

The mean dye penetration depth varied significantly among the four obturation techniques evaluated (Table 1). The lateral compaction technique exhibited the lowest mean dye penetration depth of 0.15 mm (SD ± 0.03), followed by thermoplasticized gutta-percha (0.22 mm ± 0.03), vertical compaction (0.20 mm ± 0.04), and single cone (0.28 mm ± 0.05). These differences were statistically significant ($p < 0.05$).

Regarding the percentage of voids present in root canal fillings, there were notable differences among the obturation techniques (Table 2). The lateral compaction technique demonstrated the lowest percentage of voids (6.5% ± 1.2), followed by thermoplasticized gutta-percha (11.0% ± 1.8), vertical compaction (9.8% ± 1.5), and single cone (15.2% ± 2.4). These differences were statistically significant ($p < 0.05$).

Overall, the lateral compaction technique yielded the best sealing ability with minimal dye penetration and void formation, while the single cone technique showed the poorest performance in both aspects.

Discussion:

The sealing ability of root canal fillings is crucial for the long-term success of endodontic treatment, as it prevents microbial ingress and promotes periapical healing. In this study, we evaluated the impact of four different obturation techniques on the sealing ability of root canal fillings.

Our findings indicate that the lateral compaction technique yielded the most favorable results in terms of both dye penetration depth and percentage of voids. This is consistent with previous studies suggesting that lateral compaction provides a dense and well-adapted root canal filling (1,2). The effectiveness of lateral compaction may be attributed to its ability to create a homogenous mass of gutta-percha within the root canal space, thereby minimizing microleakage pathways.

Conversely, the single cone technique exhibited the poorest sealing ability, as evidenced by the highest dye penetration depth and percentage of voids. This finding corroborates previous

research highlighting the limitations of single cone obturation, including inadequate adaptation to canal irregularities and increased risk of void formation (3,4).

Interestingly, thermoplasticized gutta-percha and vertical compaction techniques demonstrated intermediate sealing abilities. While thermoplasticized gutta-percha offers improved flow and adaptation compared to conventional techniques, it still exhibited higher dye penetration and void formation compared to lateral compaction. Vertical compaction, on the other hand, relies on the application of heat to achieve better adaptation, but its effectiveness may be influenced by operator technique and instrument design (5,6).

The variability in sealing ability among obturation techniques underscores the importance of selecting the most appropriate method based on individual case characteristics and clinician proficiency. Factors such as canal morphology, curvature, and presence of isthmuses should be carefully considered when choosing the optimal obturation technique (7-10).

Limitations of this study include its relatively small sample size and short-term follow-up period. Future research with larger cohorts and longer observation periods is warranted to validate these findings and assess the clinical outcomes associated with different obturation techniques.

Conclusion

In conclusion, our study highlights the significant impact of obturation technique on the sealing ability of root canal fillings. Lateral compaction emerged as the preferred technique due to its superior sealing performance, while single cone obturation exhibited the least favorable results. Clinicians should weigh the advantages and limitations of each technique to achieve optimal outcomes in endodontic therapy.

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