



Influence of Root End Preparation Technique on Apical Sealing Ability of Retrograde Filling: An In Vitro Study

¹Dr. Pradnya V. Bansode, ²Dr. M. B. Wavdhane, ³Dr. Seema D. Pathak, ⁴Dr. Shweta Chavan

¹Professor & Head, ^{2,3}Associate Professor, ⁴Post Graduate Student,
Dept. of Conservative Dentistry and Endodontics,
Government Dental College And Hospital, Chhatrapati Sambhajnagar

***Corresponding Author:**

Dr. Shweta Chavan

Post Graduate Student,

Dept. of Conservative Dentistry and Endodontics,
Government Dental College And Hospital, Chhatrapati Sambhajnagar

Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Aim: An in vitro study was carried out in the Department of Conservative Dentistry & Endodontics, Chh. Sambhajnagar, to evaluate the sealing effectiveness of Round Bur, Ultrasonic Endo Retro Tip, and Er: YAG laser in preparation of Root end Cavity using similar sealing material.

Methodology: 30 teeth samples were divided into 3 groups: Round bur, Ultrasonic, and Laser groups. Root canal treatment was performed on all samples. Then, the root ends were resected and root end cavities were prepared using different methods. Cavities were sealed by Bioceramic putty and then all samples were kept in methylene blue dye for 48 hrs. Samples were sectioned longitudinally and were observed under a stereomicroscope for the penetration of dye.

Results: The laser group shows less microleakage, the ultrasonic group shows more leakage and the Round Bur showed maximum leakage, with the laser group showing significantly less leakage than the other two groups.

Conclusion: In this study, the results suggest that Er: YAG laser treatment shows less microleakage than the other two groups when used for retrograde cavity preparation.

Keywords: apical microleakage, root end cavity, laser, ultrasonic, round bur

Introduction

Successful periradicular surgery relies on establishing an effective apical seal following root-end resection and retrograde filling. Apical microleakage remains a major factor contributing to surgical endodontic failure, as it permits the penetration of bacteria and tissue fluids, thereby compromising healing. The quality of root-end cavity preparation plays a vital role in eliminating anatomical irregularities, achieving adequate cavity depth, and producing a clean, well-defined preparation that supports optimal retrograde filling.

Over time, various techniques have been introduced to improve the accuracy and efficiency of root-end cavity

preparation. Conventional burs have been commonly employed; however, retrograde cavities prepared using burs demonstrate a success rate of nearly 60%. [1] In contrast, newer approaches such as ultrasonic and laser-assisted preparation techniques have shown promising results. The introduction of ultrasonic tips in apical surgery has significantly improved success rates, reaching up to 90%. [2] More recently, the Erbium-doped Yttrium-Aluminum Garnet (Er:YAG) laser has attracted considerable interest for root-end preparation because of its potential advantages. Nevertheless, despite advancements in instruments and materials, there is still limited evidence comparing the influence of

different preparation techniques on apical sealing ability.

Materials and Methods:

The present study was conducted in the Department of Conservative Dentistry and Endodontics at Govt. Dental College and Hospital, Chh. Sambhajinagar, after obtaining ethical clearance from the Institutional Ethical Committee.

Single rooted teeth were collected. teeth which were having straight roots and fully developed apices were selected for the study.

1. 30 Freshly extracted human single-rooted teeth with mature apices were collected, cleaned of tissue tags & external debris using ultrasonic scalers and stored in saline solution.
2. The teeth were decoronated, with a diamond disc to a root length of 14 mm as standard.
3. Working length was determined with no #10 K-file
4. The canals were instrumented in a crown-down manner up to F3 Protaper Universal rotary file system.
5. The 5.25% NaOCl and 17% EDTA & normal saline solutions were used for irrigating the specimens.
6. Root canals were dry using paper points.
7. The root canals were filled with #F3 gutta-percha coated with epoxy matrix resin-based root canal sealer.
8. The specimens were then stored at 37°C in a moist environment to allow the root canal sealer material to set.
9. Apical root end resections were performed at an angle of 90° to the long axis of the root, removing 3 mm from the apex using a straight diamond bur in low-speed cutting device under continuous saline irrigation.
10. The resected specimens were randomly divided into 3 groups(n=10) based on method of root end cavity preparation

The groups were as follows:

Group1 – Bur:

The root-end cavities were prepared with a round diamond bur to a depth of 3 mm using a low-speed

device under continuous saline irrigation and all cavities were measured with a periodontal probe.

Group 2 -Ultrasonic:

The root-end cavities of 3-mm depth were prepared using an ultrasonic retro preparation diamond tip (Woodpecker ED10 -0.6 mm diameter) , attached to Woodpecker UDS-J ultrasonic scaler unit with low power settings.

Group 3 - Er: Yag Laser:

3 mm deep root end cavities were prepared with an Er: YAG laser(LITETOUCH) using conical fiber tip (0.6 mm diameter 17 mm length) with the following parameters: 400 mJ, 20 Hz in noncontact mode.

After root end preparation with Bur , Ultrasonic retrotip and Er:YAG LASER all specimens were filled in retrograde manner with Bioceramic Putty and the material condensed with micro condensor.

- All the samples were stored for 24 hours in moist cotton.
- They were coated with two coats of nail varnish, except at the resected root surface.
- All samples were placed in different containers for Group A, Group B, and Group C, containing 2% methylene blue dye for 48 hours at 37°C Thereafter, the samples were removed, rinsed for 15 minutes under running tap water, and air-dried.
- The specimens were split longitudinally with a diamond disc using a water coolant.
- Dye penetration was checked within the root-end cavity using a stereo microscope and Microleakage was evaluated.

The degree of dye penetration was identified according to ISO specification 1405:20037:

0= no penetration

1= penetration to the cementum aspect of the preparation wall

2= penetration to the dentin aspect of the preparation wall, but not including the pulpal floor

3 = penetration, including the pulpal floor of the preparation

Observations

Stereomicroscopic evaluation of root end preparation



Statistical analysis

Statistical analysis performed using Statistical Package for Social science (SPSS) version 21 for Windows (SPSSInc Chicago, IL). Descriptive quantitative data expressed in mean and standard deviation respectively. Data normality checked by using Shapiro – Wilk test. Confidence interval is set at 95% and probability of alpha error (level of significance) set at 5%. Power of the study set at 80%. Overall intergroup comparison among three groups were done using One-way Anova ‘F’ test followed by Tukey’s post hoc test for pairwise intergroup comparison between each group.

Results

The highest mean microleakage was observed in Group 1 (Bur) (2.70 ± 0.48), followed by Group 2 (Ultrasonic) (2.00 ± 0.67), while Group 3 (Laser) demonstrated the lowest mean score (0.40 ± 0.52). The range of scores further supports this trend, with the

laser group showing minimal microleakage (0–1), whereas the bur group exhibited consistently higher scores (2–3). (Table 1)

Intergroup comparison using one-way ANOVA (Table 2) revealed a statistically highly significant difference among the groups ($F = 44.15, p < 0.001$), indicating that the method of root end preparation significantly influences microleakage.

Post hoc pairwise comparison (Table 3) demonstrated that the bur group showed significantly higher microleakage compared to the ultrasonic group (mean difference = 0.70, $p = 0.025$). Furthermore, highly significant differences were observed between the bur and laser groups (mean difference = 2.30, $p < 0.001$), as well as between the ultrasonic and laser groups (mean difference = 1.60, $p < 0.001$).

Overall, the laser group exhibited the least microleakage, followed by the ultrasonic group, while the bur group showed the highest microleakage.

Table 1 - Descriptive statistics of Microleakage scores amongst different groups

Group	N	Mean	Std. Deviation (SD)	Minimum	Maximum
Group 1 (Bur)	10	2.70	0.48	2.0	3.0
Group 2 (Ultrasonic)	10	2.00	0.67	1.0	3.0
Group 3 (Laser)	10	0.40	0.52	0.0	1.0

Table 2 – Intergroup comparison of Microleakage scores between different groups

Comparison groups	F-value	p-value	Significance
Group 1 (Bur) vs Group 2 (Ultrasonic) vs Group 3 (Laser)	44.15	< 0.001*	Highly Significant

Table 3 –Multiple pairwise intergroup comparison of Microleakage scores between different groups

Comparison	Mean Difference	p-value	Result
Group 1 (Bur) vs Group 2 (Ultrasonic)	0.70	0.025*	Significant
Group 1 (Bur) vs Group 3 (Laser)	2.30	< 0.001**	Highly Significant
Group 2 (Ultrasonic) vs. Group 3 (Laser)	1.60	< 0.001**	Highly Significant

Discussion

For over a century, root-end cavities were prepared using burs; but limited access and tooth angulation often caused misdirection, leading to perforation of the root, also it produces irregular margins, and smear layer formation.[4]

Ultrasonic retrotips were introduced to address these issues, enabling precise, conservative, and deeper preparations that follow the original canal path while improving access and visibility and are used today as standard tools for retrograde cavity preparation.[5]

However, they may induce cracks in root-end cavity walls, which can compromise the apical seal, causing microleakage, and ultimately lead to failure of surgical root canal treatment.[6],[7]

With advancements in dental technology, high-power lasers are now widely use.

In this in vitro study, Laser-prepared samples consistently demonstrated lower microleakage than those prepared using ultrasonic and rotary techniques.

This is due to the laser’s Hydro photonic effect, where water-mediated micro-explosions remove the smear layer, expose dentinal tubules, and enhance

penetration and bonding of retrograde filling materials.[11] Additionally, laser irradiation creates a micro-retentive dentin surface that improves adhesion.[9]

Clinically, Lasers also offer several advantages such as

1. Reduced crack formation [10]
2. Absence of vibration and pressure during cavity preparation [12]
3. Minimal thermal damage [10]
4. Bactericidal effect [3]

Conclusion

With the available resources pertaining to this study, it is concluded that

1. Retrograde preparation carried out with Er:YAG laser showed comparatively less microleakage when compared to the use of ultrasonic retrotip and burs, and thus improve the quality of endodontic root end surgeries.
2. These findings support the use of advanced preparation modalities to minimize apical microleakage in root end surgeries.

References

1. Allen RK, Newton CW, Brown CE Jr. A statistical analysis of surgical and nonsurgical endodontic retreatment case. *J Endod* 1989;15:261-6.
2. Rubinstein RA, Kim S. Long-term follow-up of cases considered healed one year after apical microsurgery. *J Endod* 2002;28:378-83.
3. Drs Georgi T. Tomov & Mutlu S. Turkkkan, Bulgaria, Apicectomy of an endodontically compromised central incisor
4. Pitt Ford TR. Surgical treatment of apical periodontitis. In: Orstavik D, Pitt Ford TR (eds) *Essential endodontology: prevention and treatment of apical periodontitis*. Blackwell Science, London, 2003; pp 278–307.
5. Karlovic Z, Pezelj-Ribaric S, Miletic I, Jukic S, Grgurevic J, Anic I. Erbium:YAG laser versus ultrasonic in preparation of root-end cavities. *J Endod* 2005;31:821-3.
6. Ishikawa H, Sawada N, Kobayashi C, Suda H. Evaluation of root-end cavity preparation using ultrasonic retrotips. *Int Endod J* 2003;36:586-90.
7. Khabbaz MG, Kerezoudis NP, Aroni E, Tsatsas V. Evaluation of different methods for the root-end cavity preparation. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004;98:237-42.
8. Tanomaru Filho M, Figueiredo FA, Tanomaru JM. Effect of different dye solutions on the evaluation of the sealing ability of mineral trioxide aggregate. *Braz Oral Res* 2005;19:119-22.
9. Pecora JD, Cussioli AL, Guerisoli DM, Marchesan MA, Sousa-Neto MD, Brugnera Junior A. Evaluation of Er:YAG laser and EDTAC on dentin adhesion of six endodontic sealers. *Braz Dent J* 2001; 12:27–30.
10. Imura Y, Yonaga K, Yokoyama K, Kinoshita J, Ogata Y, Matsumoto K. Root surface temperature increase during Er:YAG laser irradiation of root canals. *Journal of Endodontics*, 2002; 28:76–8.
11. Paghdiwala AF. Root resection of endodontically treated teeth by Er: YAG laser irradiation. *Journal of Endodontics*, 1991; 19:91-4.
12. Rosenberg SP. The use of the erbium, chromium: YSGG laser in microdentistry. *Dent Today* 2003;22:70-3