The Effect of Root End Cavity Preparation Using Er,Cr:YSGG Laser, Ultrasonic Retrotip, and Bur on the Apical Microleakage of Retrograde Cavity Filled with MTA Plus

Premjith1, Divya Shetty2, Ashika Kailar3, Sharath Pare2, Pradeep Kumar4, Mallikarjuna Ragher5

Aim: The sealing ability of the retrograde material is greatly affected by the technique used for root end preparation. Advances in retrograde preparation techniques such as lasers has shown to provide an efficient outcome. The study was to evaluate and compare the effect of various techniques of retrograde cavity preparation on apical microleakage. Materials and Methods: Forty-five single rooted teeth were decoronated. Biomechanical preparation was carried out up to size F2 ProTaper system and obturated. Glass–ionomer cement was used as an access restorative material. The apical root resection was done at 3 mm from the apex at angulation of 90° to the long axis of the root. The allocation of the samples was done into three groups of 15 each. Group A: Retrograde cavities prepared using conventional round bur; Group B: Retrograde cavities prepared using ultrasonic retro preparation diamond tip; and Group C: Retrograde cavities prepared using “Erbium, chromium: yttrium, scandium, gallium, garnet” (Er,Cr:YSGG). The retrograde cavities hence prepared were filled with MTA Plus. Nail varnish was used to coat the samples except at the apical end. Samples were immersed in methylene blue for 24 h. Stereomicroscope was used for examination of the sectioned teeth. The data were analyzed using one-way analysis of variance (ANOVA) and post hoc Tukey test. Results: Results showed very highly significant difference between laser and bur (P value = 0.001). Conclusion: Retrograde preparation with Er,Cr:YSGG showed significantly less microleakage when compared to the use of ultrasonic retrotip and burs.

Keywords: Erbium, chromium: yttrium, scandium, gallium, garnet lasers, microleakage, retrograde preparation techniques

INTRODUCTION

The complexities that remain after conventional endodontic treatment can be solved many a times by retrograde surgery. Placement of an impervious seal following root end resection prevents leakage from the canal system into the periapex. Success rate of retrograde cavity preparation of traditional apical surgery done with burs is approximately 60%,[1] Surgical endodontic therapy comprises exposure of the involved apex, resection of apical end, preparation of a cavity, and restoring the same with a filling material.[2] Burs have been normally used for the preparation of retrograde cavities. However, newer preparation techniques include the use of ultrasonics and lasers.[3] Use of ultrasonic tips for retrograde preparation was initiated by 1976; availability of microsurgical tips to

Access this article online

Quick Response Code:
Website: www.jpbsonline.org
DOI: 10.4103/jpbs.JPBS_90_20

How to cite this article: Premjith, Shetty D, Kailar A, Pare S, Kumar P, Ragher M. The effect of root end cavity preparation using Er,Cr:YSGG laser, ultrasonic retrotip, and bur on the apical microleakage of retrograde cavity filled with MTA Plus. J Pharm Bioall Sci 2020;12:S299-303.

© 2020 Journal of Pharmacy and Bioallied Sciences | Published by Wolters Kluwer - Medknow
be used in ultrasonic devices became easily accessible around 15 years ago. Development of ultrasonic tips for apical surgery has raised the success rate up to 90%. Smaller dimensions of these microsurgical tips improved accessibility to the resected retrograde cavities.

“Erbium, chromium: yttrium, scandium, gallium, garnet” (Er,Cr:YSGG) laser has shown to be more effective than ultrasonic tips in root end preparation.

Mineral trioxide aggregate (MTA) as a retrograde material has excellent adaptation to cavity walls, good biocompatibility, and least solubility. Studies conducted previously have shown excellent success rates for MTA, ranging from 90% to 92%. The study was conducted to compare and evaluate three techniques of retrograde cavity preparation and their effects on apical microleakage.

**MATERIALS AND METHODS**

Forty-five single-rooted teeth with single canal were collected, decoronated, and the working lengths were determined. Cleaning and shaping of the canals were done up to size with F2 ProTaper system. Obturation was done using AH Plus sealer and gutta-percha. Glass-ionomer cement was used to seal the access cavities. A 3-mm depth of the root apex was resected at 90° to the long axis of the root using a straight fissure bur in a high speed handpiece with water coolant.

Samples were allotted into the following three groups of 15 each:

- **Group A**: Retrograde cavities of 3-mm depth were prepared using conventional round bur
- **Group B**: Retrograde cavities of 3-mm depth were prepared using ultrasonic retro preparation diamond tip (SybronEndo, Sybron Endo Corporation, Orange, CA, USA; BK3-R) retrotip attached to EMS minipiezon scaler pre-set to Endo setting program for ultrasonics
- **Group C**: Retrograde cavities of 3-mm depth were prepared using “Er,Cr:YSGG laser” (Waterlase MD Laser; BioLase Technology, Unicorn Denmart Limited, New Delhi, India) with parameters: 4 W, 55% water, and 65% air in noncontact mode

MTA Plus was used to fill the retrograde cavities and was allowed to set for 55 min. Nail varnish was used to coat the samples except the resected root end and apical 2 mm. All samples were then submerged in methylene blue dye for 24 h.

Longitudinal sectioning of the samples was carried out into two halves, and they were examined under a stereomicroscope. The digital image was viewed on the computer, and the extent of microleakage was marked and measured using Motic Plus 2.0 software [Figure 1A–C].

**Figure 1**: (A) Group A: Stereomicroscopic evaluation of root end preparation done by bur. (B) Group B: Stereomicroscopic evaluation of root end preparation done by an Ultrasonic retrotip. (C) Group C: Stereomicroscopic evaluation of root end preparation using Er, Cr:YSGG laser
Statistical analysis
Data were analyzed using one-way analysis of variance (ANOVA). In case of significant differences between the groups, a post hoc Tukey test was used.

RESULTS
Mean microleakage of burs group was 2.016 ± 0.925, ultrasonic group was 1.117 ± 0.755, and laser group was 1.003 ± 0.454, showing that laser group has least microleakage values [Table 1]. Microleakage results showed very highly significant difference between laser and bur (P value = 0.001), and highly significant difference between burs and ultrasonics (P value = 0.005) [Table 2].

DISCUSSION
The primary goal of retrograde root end surgery is to retain a tooth, which was previously endodontically treated, in which the lesion did not subside either by conventional therapy or by retreatment.

Apical root resection is a significant step in apical surgery, which aids in removing the pathologic process and anatomical variations, and gains access to the canal system. This study evaluated retrograde preparations carried out using burs, ultrasonics, and Er,Cr:YSGG laser. As maximum amount of apical canal anomalies and lateral canal system ramifications occur in the apical 3 mm,[9] hence root end resection of approximately 3 mm was carried out in this study.

According to Gilheany et al.[10] there are two means, which lead to failures in the apical area of a root sealed with a retrograde filling. One being apical microleakage, and the other by free flow of fluids through open tubules at the resected root surface.

Previous studies have suggested a 90° bevel 3 mm from the apex also removes maximum amount of root ramifications while maintaining the length of the root. In our study, a 90° bevel was given for the same reasons.[10]

Microleakage of a retrofilling material is best assessed by dye penetration, if the material in question can obstruct the leakage of smaller molecules of the dye, then they would also be able to prevent infiltration of material such as bacteria and their by-products.[11,12]

Tanomaru Filho et al.[13] concluded that the sealing ability of MTA when evaluated with 2% methylene blue dye solution was better when compared to 0.2% rhodamine B dye. Studies have proved that methylene blue is economical, easy to handle, has a better staining ability, and it has been proved that the molecular weight is lesser than bacterial toxins.[13]

Root end cavities prepared using ultrasonics have smaller dimension, provide better access and are comparatively conservative in nature when compared to cavities prepared by a micromotor handpiece and bur.[14]

Main disadvantage of ultrasonics is cracks in the root canal walls.[15] Khabbaz et al.[16] compared bur, sonic, and ultrasonic for the root end cavity preparation and showed 7%–20% cracks with ultrasonic tips. Ishikawa et al.[17] showed that burs created 10% microcracks and ultrasonics caused 60%–80% microcracks when used for root end cavity preparation. However, O’Connor et al.[18] did not find much differences between the preparation with ultrasonic tips or handpiece in the sealing of retrofillings. In our study, ultrasonic retrotip showed less microleakage when compared to burs. This might be attributed to the fact that ultrasonic retrotip resulted in less smear layer formation in a retrograde cavity in comparison to a slow-speed handpiece.[19]

| Groups | N | Mean | Std. deviation | Min. | Max. |
|--------|---|------|----------------|------|------|
| Burs   | 15| 2.016| 0.925          | 0.99 | 3.69 |
| Ultrasonic | 15| 1.117| 0.755          | 0.28 | 2.70 |
| Laser  | 15| 1.003| 0.454          | 0.57 | 2.41 |

N = number of samples in the group

| Group (I) | Group (J) | Mean difference (I – J) | P |
|-----------|-----------|-------------------------|---|
| Bur       | Ultrasonic| 0.89933                 | 0.005hs |
| Bur       | Laser     | 1.01293                 | 0.001vhs |
| Ultrasonic| Laser     | 0.11360                 | 0.907ns |

Hs = highly significant, vhs = very highly significant, ns = not significant
The “Er,Cr:YSGG” laser has been more efficient in cutting hard tissues. This laser cuts dentin with energized water molecules, keeping the temperature of the root surface low and therefore produces least thermal change.[7] Laser also makes the involved surface retentive, which would increase the bond between the sealing material and dentin.[3]

From the standpoint of chipping, hard tissue lasers have shown to preserve the integrity of retrograde cavities better than ultrasonic devices.[20] Lasers yield favorable results, including less crack formation, absence of vibration and pressure during retrograde cavity preparation, and the effective removal of debris and smear layer.[21] Koçak et al.[22] used burs, ultrasonics, and Er,Cr:YSGG laser in their study with fluid filtration method and concluded that Er,Cr:YSGG showed significantly lesser microleakage. In this study, we found that laser group showed the least microleakage when compared to ultrasonics and burs. This conclusion was reached due to an explanation that Er,Cr:YSGG laser causes micro-explosions of the water in the dentin, resulting in the removal of smear layer, thus allowing retrograde filling material to penetrate into these tubules and decrease microleakage.[15,23]

Success in surgical endodontics is achieved by obtaining a fluid impervious apical seal. The root sealing material selected should be biocompatible, have good strength, promote optimum healing, and its properties should not be altered by the presence of moisture. MTA Plus was used in this study as it has a setting time significantly shorter than ProRoot MTA.[24] According to Gandolfi et al.[25] MTA Plus showed improved reactivity and prolonged capability to release calcium ions compared to ProRoot MTA. MTA Plus also showed a more alkaline local pH in comparison with ProRoot MTA.[23] MTA Plus was chosen in this study, considering its availability and lower setting time, and thus was a suitable replacement to conventional bioactive calcium silicate MTA-like cements.

**Conclusion**

With the available resources pertaining to this study, we can come to a conclusion that retrograde preparation carried out with Er,Cr:YSGG laser showed comparatively less microleakage when compared to the use of ultrasonic retrotip and burs, and thus in total would improve the quality of endodontic root end surgeries.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**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. Torabinjed M, Watson TF, Pittford TR. Sealing ability of mineral trioxide aggregate when used as a root end filling material. J Endod 1993;19:591-5.
3. Bertrand G, Festral F, Barailly R. Use of ultrasound in apicoectomy. Quint Int 1976;7:9-12.
4. 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.
5. Rubinstein RA, Kim S. Long-term follow-up of cases considered healed one year after apical microsurgery. J Endod 2002;28:378-83.
6. Carr GB. Ultrasonic root end preparation. Dent Clin North Am 1997;41:541-54.
7. Wallace JA. Effect of Waterlase laser retrograde root-end cavity preparation on the integrity of root apices of extracted teeth as demonstrated by light microscopy. Aust Endod J 2006;32:35-9.
8. Torabinjed M, Chivian N. Clinical applications of MTA. J Endod 1999;25:197-205.
9. Vertucci F. Root canal anatomy of human permanent teeth. Oral Surg 1984;58:589.
10. Gilheany PA, Figdor D, Tyas MJ. Apical dentin permeability and microleakage associated with root end resection and retrograde filling. J Endod 1994;20:22-6.
11. Vogt BF, Xavier CB, Demarco FF, Padilha MS. Dentin penetrability evaluation of three different dyes in root-end cavities filled with mineral trioxide aggregate (MTA). Braz Oral Res 2006;20:132-6.
12. Agarwal V, Nayak D US, Sharma M, Reddy YG, Singla M, Nanda Z. Comparative evaluation of different dye solutions on the evaluation of the sealing ability of retrograde cavity preparations. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;98:237-42.
13. 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.
14. Lin CP, Chou HG, Kuo JC, Lan WH. The quality of ultrasonic root-end preparation: a quantitative study. J Endod 1998;24:666-70.
15. Kellert M, Solomon C, Chalfin H. A modern approach to surgical endodontics: ultrasonic apical preparation. N Y State Dent J 1994;60:25-8.
16. Habbabz 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.
17. Ishikawa H, Sawada N, Kobayashi C, Suda H. Evaluation of root-end cavity preparation using ultrasonic retrotips. Int Endod J 2003;36:586-90.
18. O’Connor RP, Hutter JW, Roahen JO. Leakage of amalgam and super-EBA root-end fillings using two preparation techniques and surgical microscopy. J Endod 1995;21:74-8.
19. van As G. Erbium lasers in dentistry. Dent Clin North Am 2004;48:1017-59.
20. Asnaashari M, Fekrazad R, Menshadi FD, Seifi M. The effect of Er,Cr:YSGG laser irradiation on the apical leakage of retrograde cavity. Iran Endod J 2009;4:144-8.
21. Rosenberg SP. The use of the erbium, chromium: YSGG laser in microdentistry. Dent Today 2003;22:70-3.
22. Koçak MM, Koçak S, Aktuna S, Göriçü J, Yaman SD. Sealing ability of retrofilling materials following various root-end cavity preparation techniques. Lasers Med Sci 2011;26:427-31.
23. Roghanizad N, Fekrazad R, Kahori KAM, Khalilak Z, Esmæeili MA, Fatima R, et al. A comparison of Er,Cr:YSGG laser with ultrasonic preparation on the seal of retrograde cavities. Laser Ther 2015;24:33-7.
24. Siboni F, Taddei P, Prati C, Gandolfi MG. Properties of neoMTA Plus and MTA Plus cements for endodontics. Int Endod J 2017;50:e83-94.
25. Gandolfi MG, Siboni F, Primus CM, Prati C. Ion release, porosity, solubility, and bioactivity of MTA plus tricalcium silicate. J Endod 2014;40:1632-7.