ORIGINAL RESEARCH PAPER
Volume-9 | Issue-2 | February-2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

EVALUATION OF APICAL MICROLEAKAGE OF ROOT- END CAVITIES PREPARED BY ER:YAG LASER: AN IN VITRO STUDY

Clinical Research

Dr. Shyam Agrawal Reader, Department Of Conservative Dentistry And Endodontics, NIMS Dental college & Hospital

Dr. Harshit Srivastava Reader, Department Of Conservative Dentistry And Endodontics, Mahatma Gandhi Dental College and Hospital

Dr. Rachit Mathur Reader , Department Of Conservative Dentistry And Endodontics, NIMS Dental college & Hospital

Dr. Aastha Arora Reader, Department Of Conservative Dentistry And Endodontics, Rajasthan dental college and hospital

Dr. Mohsin kamaal* 3rd Year Resident , Department Of Conservative Dentistry And Endodontics, Mahatma Gandhi Dental College and Hospital *Corresponding Author

Dr. Rahul Chaudhari 2rd Year Resident , Department Of Conservative Dentistry And Endodontics, Mahatma Gandhi Dental College and Hospital

ABSTRACT

Aim: The aim of apical surgery is to eliminate periapical infection. An in vitro study was carried out in the Department of Conservative Dentistry &Endodontics, Ahmedabad, to evaluate the sealing effectiveness of Er:YAG laser, Ultrasonic Endo Retro Tip, and Round Bur in preparation of Root end Cavity using similar sealing material.

Methodology: 52 tooth samples were divided into 3 groups: Laser group, Ultrasonic group, and Round bur group. Root canal treatment was performed on all samples. Then root ends were resected and root end cavities were prepared using different methods. Cavities were sealed by IRM and then all samples were kept in basic fuchsin dye for 48 hrs. Samples were sectioned longitudinally and were observed under stereomicroscope for the penetration of dye.

Results: Laser group shows less microleakage(mean=0.96mm), Ultrasonic group shows more leakage(2.14mm) and Round Bur showed maximum leakage(2.38mm) with laser group shows significantly less leakage than other two groups. But no statistically significant difference was found between ultrasonic and round bur group. Conclusion: In this reference, the results of the present study suggest that, Er:YAG laser treatment shows less microleakage compared to other two groups when used for retrograde cavity preparation.

KEYWORDS

apical microleakage, root end cavity, laser, endo retro tip, round bur

INTRODUCTION:

An Apicoectomy, or Root-End Resection, is the removal of the root tip and the surrounding infected tissue of an involved tooth. This procedure may be necessary when inflammation and infection persists in the area around the root apex in large periapical lesion, open apex or after root canal therapy or retreatment. Prime important in the procedure is the preparation of the root end and placement of a filling material which gives a long lasting seal.1 Ideal root end cavity preparation is one of the difficult tasks to perform owing to the problems of limited access, root anatomy and tooth angulations But newer advents in the horizon has added ease and precision to the procedure. This includes devices ranging from sonic to ultrasonic's and lasers.2 The newer generations of ultrasonic devices, retro tips, have claimed to be more simplified and faster, leading to more conservative preparation of root end cavity.3However higher incidence of cracks in dentinal walls is one prominent disadvantage. 4-7 In the present years, lasers have become a special tool in dentistry. Today, many hard and soft tissue lasers, with different wavelengths, are available for use in almost all fields of dentistry and more & more are being developed, thus providing the wider choice for the dentist to upgrade the practice along with this fastest growing field of laser dentistry. The possible multiple uses of laser in dentistry include replacement of the dental drill with laser. For e.g. Root end cavity preparation with LASER.

Several advantages of Er: YAG laser for apicoectomy has been stated by Komori et al., like lack of vibration, lower possibility of operating field contamination, less trauma to surrounding tissues, increased patient acceptance. Besides, Er: YAG is the one of the only lasers to be approved by the U.S. Food and Drug Administration for cavity preparation. 8,9

The aim of this in vitro study was to investigate the effect of root end cavity preparation methods - Er:YAG Laser, Ultrasonic Retrotips or Rotary Instrument – on apical leakage. Thereby, to assess the sealing effectiveness of the Er: YAG laser to sealing effectiveness of an ultrasonic device and round bur in the preparation of retrograde cavities using similar retrograde filling material.

METHODOLOGY:

This study was carried out in the department of Conservative Dentistry and Endodontics of Govt. Dental College and Hospital, Ahmedabad. Maxillary central incisors were collected from the Oral Surgery Department of GDCH, Ahmedabad. Teeth which were having straight roots and fully developed apices were selected for the study. Fifty two sample teeth were collected. The teeth were cleaned of tissue tags and debris and stored in normal saline solution.

All teeth were opened with round bur no.2/4 and proper enlargement of access cavity was done with tapered fissure bur and Gates Glidden burs. After access opening biomechanical preparation was done. All teeth were enlarged to a size 50 master file 1 mm from the anatomical apex. The root canals were flared using the step-back technique. Irrigation was performed with 2% NaOCl. The canals were dried with paper points (Dentsply, Switzerland) and obturated with laterally condensed gutta-percha using sealer (AH plus, Dentsply, Germany). The access cavities were filled with bonded composite resin.

Root-end resection was performed at 90 degrees to the long axis of the root 3 mm from the apex, using diamond disk, under copious saline irrigation. Four teeth were used as positive and negative controls. For positive control, no varnish or root-end filling was applied. The remaining 48 teeth were randomly divided into three equal groups (n _ 16).

GROUPING:

1. GROUP L (Laser group): The root-end cavities were made using the Er:YAG laser device Fidelis (Fotona, Slovenia).

2. GROUP U (Ultrasonic group): The root-end cavities were prepared using S12-90ND retrotip on an ultrasonic unit Newtron(SATELEC, Acteon Group, France)

3. GROUP R (Round Bur group): The root end cavities were prepared by a round bur (no. 010) used at 5000 rpm under saline irrigation upto specified depth of 3mm.

4. CONTROL GROUP:
(a) Positive group: In this group no varnish or root end filling was applied.

(b) Negative group: One tooth from each group was selected randomly after root end cavity preparation and filling.

GROUP L (Laser group): The root-end cavities were made using the Er:YAG laser device Fidelis (Fotona, Slovenia). Wavelength was 2.94µm, energy was set at 280 mJ/pulse, and repetition rate was 15 Hz. Pulse width was 100 µs (very short pulse). The laser radiation was applied manually through a fiber tip 1.5 cm long with diameter of 940µm in the contact mode with water-spray cooling (70 psi). All root ends were prepared by one operator. The root-end cavities were considered complete when all preparations, including the obturated canals, were 3-mm deep and no visible guttapercha remained on the cavity walls.

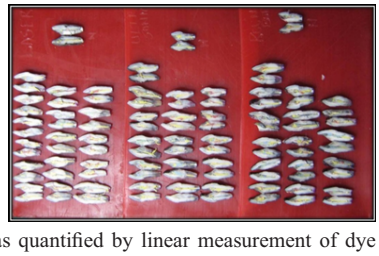
GROUP U (Ultrasonic group): The root-end cavities were prepared using S12-90ND retrotip on an ultrasonic unit Newtron(SATELEC, Acteon Group, France) at moderate power setting(5-9) and intermittent pressure with in and out motion to start preparation, then increased the depth up to 3 mm from the resected surface, and finally moved the tip circumferentially to complete the preparation.

GROUP R (Round Bur group): The root end cavities were prepared by a round bur (no. 010) used at 5000 rpm under saline irrigation up to specified depth of 3mm.

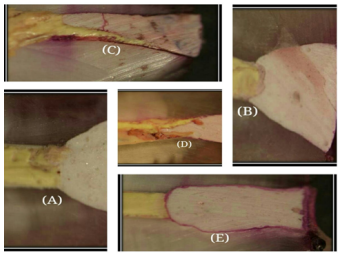
CONTROL GROUP: (a) Positive group: In this group no varnish or root end filling was applied. (b) Negative group: One tooth from each group was selected randomly after root end cavity preparation and filling.

Then each sample was coated with double layer of nail varnish completely including apical surface to test the reliability of the isolation method. Root-end cavities in all groups were dried by air spray and filled with IRM (Dentsply) i.e. intermediate restorative material. All the teeth except control group were isolated with two layers of nail varnish, excluding the cut apical surface, and immersed in 0.2% basic fuchsin and kept in incubator at 36°C for 48 hours.

The roots were split longitudinally with a diamond disk mounted on a micromotor hand piece. Sections were examined at 40X magnification by a stereomicroscope equipped with cool light unit (Olympus, Japan). (Fig 1)



Leakage was quantified by linear measurement of dye penetration. Digital images of the sectioned roots were captured using a camera (Olympus, Japan) attached to the stereomicroscope, and linear retrograde dye leakage was measured with the aid of image analyzing software (Image J 1.43U). (Fig 2)



A standard ruler was included in each image to be used for calibrating the software before each measurement. Data collected was evaluated for statistical analysis. The data was then, analyzed using ANOVA test and difference between the group were found using TUKEY HSD test.

RESULTS:
Statistical analysis of result showed significant difference among samples prepared by laser, ultrasonic and round bur technique. The results of present study showed that laser group had significantly less micro-leakage than the other two groups, ultrasonic group and round bur group. ANOVA test showed that the difference between the laser group and other two groups were statistically significant at P-value < 0.001.(TableI) Post hoc test also shows same result as ANOVA test.(Table II)

Sealing effectiveness was greater in laser group followed by ultrasonic group followed by round bur group. As such there is no significant difference between ultrasonic group and round bur group.

Table 1: Difference in micro-leakage in laser group, ultrasonic group and round bur group [ANOVA test]

ANOVA TABLE					
			Mean Square	F	Sig.
Mean* method	Between Groups	Combined	9.287	51.035	0.000
		Linearity	16.262	89.362	0.000
		Deviation from linearity	2.312	12.708	0.001
		Within groups	0.182		

Table 2: Multiple comparisons in laser group, ultrasonic group and Round bur group in microleakage [Post hoc test]

(I) Method	(J) Method				95%confidence interval	
		Mean difference (I-J)	Std. error	Sig.	Lower bound	Upper bound
L	U	-1.178477*	0.150820	0.000	-1.54401	-.81295
	R	-1.425726*	0.150820	0.000	-1.79126	-1.06020
U	L	1.178477*	0.150820	0.000	0.81295	1.54401
	R	0.247249	0.150820	0.240	-.61278	0.11828
R	L	1.425726*	0.150820	0.000	1.06020	1.79126
	U	0.247249	0.150820	0.240	-.11828	0.61278

DISCUSSION:
The aim of apical surgery is to eliminate periapical infection. In this procedure, pathologic tissues surrounding the apex are removed and the apical end of the root is usually resected when re-treating a complex root-canal system. Following the apical resection, a root-end filling is required in most cases10An appropriate root-end filling substantially prevents the transfer of fluid and microbial products into the root canal system from periapical tissues.11 The success of the apical filling depends on the type of the filling material and careful preparation of the root-end cavity. 4

An appropriate root-end cavity must be 3 mm deep, located at the center of the root, and parallel to the long axis of the root.11A well-adapted filling material in a properly prepared retrograde cavity is crucial for the success of periapical or periradicular surgery.2

For more than a century, root-end cavities have been prepared with burs, but limited access and tooth angulations lead to misdirection of the burs, sometimes resulting in perforation of the root.12 To overcome these difficulties, ultrasonic retrotips connected to ultrasonic devices have been developed, allowing small and deep root-end cavity preparations and can easily follow the original path of the root canal3and are used today as standard tools for retrograde cavity preparation.2 Ultrasonic has advantage of improved access to the surgical site, and more conservative preparation.2However, ultrasonic retrotips may also create cracks along the wall of the root-end cavities4 Cracks can lead to disintegration of the sealed apical end, which in turn leads to microleakage; therefore, surgical root canal treatment usually fails. Today, thanks to innovations of advanced technology, dental laser systems are widely used. High-power lasers, with proper use and at an optimum setting for target tissue, lead to desired results: reducing dentin permeability, cavity preparation without vibration, and assisting disinfection during canal instrumentation. To improve the

apical sealing, CO2, diode, Erbium: YAG lasers have been used experimentally.

In the present in vitro study we compared the apical leakage of root-end cavities prepared by Er:YAG laser, ultrasonic retrotip, and rotary instrument(round bur). In in-vitro conditions, samples prepared using laser technique has shown smaller micro-leakage than those prepared using an ultrasonic device and round bur. Explanation for lesser micro-leakage is removal of the smear layer by the Er:YAG laser13(54) and exposure of dentinal tubules, which enables the retrograde filling to penetrate into them and create tags especially if we use resin cement. Another reason for this was laser irradiation which leaves an irregular surface of intertubular dentine, an area termed micro-retentive, and that enables higher mechanical bonding between root-end filling and dentinal walls.14

The another dye penetration study of retrograde cavities prepared by CO2 laser, ultrasonic retrotip, or rotary instrument filled with amalgam, showed significantly less leakage in the laser group and is in accordance with this study. 15 So, CO2 laser was also used for the same and had shown less micro-leakage but due to its thermal effect on surrounding tissues limited its use in this area. As CO2 laser is absorbed much better in collagen than in water, thus it seems that the interaction cannot avoid direct heating of the tissue. 16

As Nd:YAG laser seals orifices of dentinal tubules and does not provide such dentinal surface hence cannot be used for retrograde cavity preparation.17

Previously Er:YAG laser with a pulse width of 250µs had been used in endodontic surgery for root resection.18Apel et al.19 showed that pulses of shorter duration reduced the limit at which ablation of dental enamel started by approximately 3 J/cm2. In our study we have used very short pulse (100µs) that enabled a high efficacy in hard tissue removal so we could expect no cracks in dentinal walls and minimal or even no thermal damages, which is in accordance with the study of Kimura et al.20 They found minimal thermal effect on periodontal tissue during root canal preparation using an Er:YAG laser. Another study in which samples apicoectomized with CO2 and Er:YAG laser have reduced micro-leakage compared to the samples prepared with a high-speed bur. In their study the analysis of methylene blue dye infiltration through the dentinal surface and the retro filling material demonstrated that the samples from the groups irradiated with the lasers showed significantly lower infiltration indexes. They also stated that samples treated with Er:YAG laser have clean surfaces of dentine, without smear layer . 21

Another study by Kimura et al20 showed that root canal samples prepared with Er:YAG laser and obturated do not leak less than the root canals conventionally prepared. Thus this study doesn't prove any additional advantage of laser over conventional method of RCT.

Sealing ability of root canal sealers depends not only on an appearance of dentine surface but also on the type of material used. Sousa- Neto22 found that epoxy resin-based sealers adhere better to dentine than the oxide/eugenol-based sealers. So we have used AH Plus sealer.

IRM assures a good apical seal.23 Many studies are in support of this statement. Even after a 24-wk setting time of IRM, it assures a good seal. 24 Thus these studies guided us to use IRM as retrograde filling material. And it should be considered that this study investigates the effect of root end cavity preparation method on apical leakage, rather than the effect of filling material.

Ultrasonic root-end preparation is a recognized clinical procedure. Despite the advantages of ultrasonic root-end preparation, there are controversies regarding the formation of cracks or micro-fractures and the implications for healing success associated with this technique. Several experimental studies4-7 have shown some degree of crack formation. Results of the present study showed no significant difference in root-end micro-leakage between the ultrasonic and the bur groups, This is consistent with the results of the studies reported by Saunders et al25 andO'Connor et al . 26

In the present study undertaken, three methods for root end cavity preparation were assessed and their sealing effectiveness was checked by comparing micro-leakage using 0.2% basic fuchsin dye under stereomicroscope.

Dye penetration studies to indicate leakage were first utilized by Grossman, Methylene blue dye was used for dye penetration. The dye penetration test is a simple method. It gives a clearly contrasting view during evaluation. In another study it was shown that a dye solution penetrated further than radio-isotope solutions.27 Furthermore by using a dye, radioactive contamination can be avoided. In the present study we have used basic fuchsin dye as this dye is having very small molecules which are easy to penetrate through apical foramen.

The result of the present study "Apical Microleakage of Root- End Cavities Prepared By Er:YAG Laser " showed that all three groups showed apical leakage but there was statistically significant difference between the laser group and the other two ultrasonic group & round bur group. Whereas the ultrasonic group and round bur group shows no significant difference.

According to this study, the Er:YAG laser could be used for retrograde cavity preparation, although some clinical limits of this Erbium laser still have to be overcome, such as size of the handpiece and diameter of fiber. One of the utmost important things which should be kept in mind is that LASERS required very high precision while working and is very technique sensitive. Although there are so much advantages, but slight negligence of the dentist can lead to damage to surrounding tissues.

CONCLUSION:

Therefore, in conclusion – based on the present study results, 2.94 µmEr:YAG laser irradiation with energy of 280mJ/pulse and a pulse duration of 100 µs produced an effective protection against the microleakage, so that: the use of a pulsed Er:YAG laser at 2.94µm might be a good alternative for the root end cavity preparation compared to ultrasonics or more conventional methods like rotary burs.

However, demonstration of similar results in a clinical situation, as well as determination of safety of this treatment modality, warrants the need for further verifiable and multicentric investigations, before the preventive effect of lasers is contemplated to be applicable in clinical situations.

This study was performed on extracted human teeth, which simplified the root-end preparation procedure. So further studies are needed that should be done directly in patients i.e. in vivo.

REFERENCES:

1. Esen E, Yoldas O, Kurkcu M, Dogan MC, Seydaoglu G. Apical microleakage of root end cavities prepared by CO2 laser. Journal of Endodontics 2004; 30:662– 4.
2. ZoranKarlovic, Sonja Pezelj-Ribaric, IvanaMiletic, SilvanaJukic, JoskoGrgurevic, and IvicaAnic.Er:YAG laser versus ultrasonic in preparation of root-end cavities.Journal of Endodontics, 2005;31 :(11).
3. Von Arx T, Kurt B, Ligenstein B, Hardt N. Preliminary results and analysis of a new set of sonic instruments for root end cavity preparation. International Endodontic Journal; 1998; 31:32-38.
4. Abedi H R, Van MierloB L, Wilder-Smith P, Torabinejad M. Effects of Ultrasonic Root End Cavity Preparation on the Root Apex. Oral Surg Oral Med Oral Pathol Oral RadiolEndod, 1995; 80:207-213.
5. Beling KL, Marshall JG, Morgan LA, Baumgartner JC. Evaluation of cracks associated with ultrasonic root end preparation of guttapercha filled canals. Journal of Endodontics 1997; 23:323-326.
6. Layton CA, Marshall JG, Morgan LA, Baumgartner JC. Evaluation of cracks associated with ultrasonic root end preparation. Journal of Endodontics, 1998; 20:157-160.
7. Min MM, Brown CE Jr, Legan JJ, Kafrawy AH. Invitro evaluation of effects of ultrasonic root end preparation of resected root surfaces. Journal of Endodontics, 1997; 23:624-628.
8. Komori T, Yokoyama K, Takato T, Matsumoto K. Clinical application of the Er:YAG laser for apicoectomy. Journal of Endodontics, 1997; 23:748-750.
9. Wuchenich G, Meadows D, Torabinejad M. A comparison between two root end preparation techniques in human cadavers. Journal of Endodontics, 1994; 20:279–282.
10. Johnson BR. Considerations in the selection of a root-end filling material. Oral Surg Oral Med Oral Pathol Oral RadiolEndod 1999; 87:398–404.
11. Syngulk K. Endodontic Microsurgery2002. In: Cohen S, Burns RC (Eds) Pathways of the Pulp. C.V. Mosby, St. Louis, P 708.
12. 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.
13. Paghdiwala AF. Root resection of endodontically treated teeth by Er: YAG laser irradiation. Journal of Endodontics, 1991; 19:91-4.
14. 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.
15. Esen E, Yoldas O, Kurkcu M, Dogan MC, Seydaoglu G. Apical microleakage of root end cavities prepared by CO2 laser. Journal of Endodontics 2004; 30:662– 4.
16. Harvey A. Wigdor, Joseph T. Walsh, Jr., John D.B. Featherstone, Steven R. Visuri, Daniel Fried, and Joseph L. Waldvogel. Lasers in Dentistry. Lasers in Surgery and Medicine, 1995; 16:103-133.
17. Lan WH, Lee BS, Liu HC, Lin CP. Morphologic study of Nd:YAG laser usage in treatment of dentinal hypersensitivity. Journal of Endodontics, 2004; 30:131– 4.
18. Gouw-Soares S, Tanji S, Haypek P, Cardoso W, Eduardo CP. The use of Er:YAG, Nd:YAG and Ga-Al-As lasers in periapical surgery: a 3-year clinical study. J Clin Laser Med Surg 2001; 19:193– 8.

19. Apel C, Franzen R, Meiter J, Sarrafzadegan H, Thelen S, Gutknecht N. Influence of the pulse duration of an Er:YAG laser system on the ablation threshold of dental enamel. Lasers SurgSci 2002; 17:253–7.
20. Kimura 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.
21. Gouw-Soares, Stabholz A, Lage-Marques JL, Zezell DM, Groth EB, Eduardo CP. Comparative study of dentine permeability after apicectomy and surface treatment with 9.6 microm TEA CO2 and Er:YAG laser irradiation. J Clin Laser Med Surg. 2004; 22(2):129-39.
22. Sousa-Neto MD, Marchesan MA, Pecora JD, Junior AB, Silva-Sousa YT, Saquy PC. Effect of Er:YAG laser on adhesion of root canal sealers. Journal of Endodontics, 2002; 28:185–7.
23. Crooks WG, Anderson RW, Powell BJ, Kimbrough WF. Longitudinal evaluation of the seal of IRM root end fillings. Journal of Endodontics 1994; 250 –2.
24. Inoue S, Yoshimura M, Tinkle JS, Marshall FJ. A 24-week study of the microleakage of our retrofilling materials using a fluid filtration method. Journal of Endodontics, 1991; 17:369 –75.
25. Saunders WP, Saunders EM, Gutmann JL. Ultrasonic root-end preparation, Part 2. Microleakage of EBA root-end fillings. International Endodontic Journal, 1994; 27:325–329.
26. O'Connor RP, Hutter JW, Roahen JO. Leakage of amalgam and Super- EBA root-end fillings using two preparation techniques and surgical microscopy. Journal of Endodontics, 1995; 21:74–8.
27. Matloff I.R., Jensen J.R., Singer L. and Tabibi A. "A comparison of methods used in root canal sealability studies". Oral Surg Oral Med Oral Pathol Oral RadiolEndod, 1982; 53(2): 203-208.