

Healing of Apical Periodontitis after Minimally Invasive Endodontics therapy using Er,Cr:YSGG laser: A Prospective Clinical Study

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ABSTRACT

The aim of the present study was to clarify the healing percentages for a 6-months duration after clinical endodontic treatment, in cases treated by Er,Cr:YSGG laser (Waterlase MD; Biolase Technology, Inc, San Clement, CA) and filled by two obturation techniques.

The study group were composed of 40 patients, who were referred for endodontic treatment and diagnosed having apical periodontitis they received well-performed minimally invasive nonsurgical root canal treatment with ProTaper Next instruments (Dentsply Maillefer, Ballagues, Switzerland) and copiously irrigation with 2 mL 5% NaOCl . After instrumentation, laser irradiation was performed for smear layer removal with Er,Cr:YSGG laser 2,780 nm wavelength with a radial firing tips RFT2 and RFT3 [diameter 200 µm for apical and middle third and 320 µm for coronal third respectively]. After laser irradiation, a final irrigation was done with 5ml of Saline solution. Then, disinfection for the root canal was done with the same laser device. The subjects were divided into 2 groups; the first one was obturated with carrier-based technique(GuttaCore, Dentsply Maillefer, Ballagues, Switzerland) and the other with cold lateral compaction technique , AH Plus sealer (Dentsply Tulsa Dental Specialties, Tulsa, OK)was used in both groups.

Healing of the different apical periodontitis cases was evaluated clinically and radiographically employing Periapical index (PAI) scoring. According to this evaluation, three conditions could be distinguished :

healed, healing, or diseased. Successed cases includes healed or healing conditions which accompanied the success of root canal treatment. Statistical analysis was done by using independent t-test, Univariate (ONE WAY ANOVA) test, and Pearson coefficient.Differences between variables were setting as significant at 5% ($P \leq 0.05$) and highly significant at 1% ($P \leq 0.01$).

The prognosis of healing rates was compared temporally. Forty patients were followed up at three recall periods at 1-month, 3-month, and 6-month after treatment. The success of root canal treatment for these periods was 67.5%, 82.5%, and 97.5%, respectively.

In conclusion, the teeth of different apical diagnosis can be treated with the Er,Cr:YSGG laser.It showed a tremendous degree of success of root canal treatment in aperiod of 6 months after treatment. The Er,Cr:YSGG laser permit for rapid rate of healing with a predictable outcome.

Key Words: YSGG Laser, Irradiation, Peridontitis, Univariate.

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INTRODUCTION

The most important requirements of rewarding root canal treatments claimed to eradicate all organic substrates from canal wall and lumen, and to obturate root canals with a hermic seal. Beside that, appropriate cleaning and shaping is required for decent result which required an increase in the diameter size of the root canal.(1)

On the other hand, the durability of endodontically treated tooth is a crucial parameter. Concerning this concept, Minimally invasive endodontics (MIE) can be utilised for ultimate conservation of healthy dental structure during root canal treatment. To get a rewarding result, there should be a balancing between preservation and removing of dentine during instrumentation .(2)

Another important parameter is a disinfection of the root canal system. Ideal instrumentation and disinfection play a major rule in the healing of periradicular tissue and root canal treatment success(3). Determining the affecting elements will guid dentists anticipate the fallout of root canal treatment(4)

Various devices and techniques of irrigation are advanced to promote the washing of endodontic treatment. among of these irrigation techniques, negative pressure, sonic, ultrasonic, photon-induced photoacoustic streaming (PIPS), and laser applications (5,6).

Laser applications in dentistry have been advanced a lot specially in endodontic treatments. One of these important applications is clearing away smear layer from radicular dentine(7,8) and getting deep radicular

sterilisation(9,10). There are many lasers used for this purpose, erbium, chromium:yttrium–scandium–gallium–garnet (Er,Cr:YSGG) laser(2,780 nm), has been exhibited qualified smear layer removal(11) and better endodontic disinfection than some traditional ways (12) without any hazards to adjacent tissues (13,14).

The aim of the present study was to clarify the healing percentages for a 6-months duration after clinical endodontic treatment, in cases treated by Er,Cr:YSGG laser and filled by two obturation techniques.It was guesstimated that the healing percentage checked at 6 months will be decreased.

MATERIALS AND METHODS

The study cohort was composed of 40 patients, who were referred for endodontic treatment and diagnosed of having apical periodontitis. This clinical study was done in conformity with the Declaration of Helsinki. An informed consent form was signed by all patients before being involved. This study assessed the healing of apical periodontitis after root canal treated by Er,Cr:YSGG laser. This plan was elucidated to all participators before the stating of the treatment. the selection of persons followed an exclusion and inclusion criteria.

Inclusion and Exclusion Criteria

Patients aged from 12-60 years old were included in this study. they received well-performed minmaly invasive nonsurgical endodontic therapy. All patients had

preoperative clinical and radiographic evidence of apical periodontal diseases. The first molar was the subjected tooth.

Patients were excluded if their teeth present with earlier pulpotomy, pulpectomy, or any endodontic interventions. Beside that, mobile teeth with a score ≥ 2 , teeth present with a periodontal problems with more than 6 mm pocket depth, and teeth with undeveloped root apices. Also the patients will rule out if they were taking any medications that might disturb the metabolism of bone like, immunosuppressive, selective serotonin reuptake inhibitors, intravenous bisphosphonates, corticosteroids, hormone replacement therapy, tumor necrosis factor blockers, antiresorptive treatment, and others.

Preoperative Data Collection

A thorough preoperative clinical examination was performed for each patient and supported by radiographic records. This examination includes a patient's medical history and previous dental work, in addition to an intraoral assessment which encompassed the mobility testing, calculation of the periodontal pocket depths. Also the swelling and soft tissue lesions if any, palpation, and percussion were recorded. After that, a pulpal and periradicular diagnosis was concluded and documented. The parallel periapical radiographic technique was used and the radiographs analysed according to periapical index score.

A coded data sheets were used, these sheets contain edited radiographic and clinical data belonging to each acused tooth at different periods: before (preoperative), after (postoperative), after one month, and at 3-month intervals from the date of obturation up to 6 months.

Treatment Procedure

Firstful, 2% lidocaine anesthetic solution with 1:100,000 epinephrine was given for patients to be more comfortable. A rubber dam was used to isolated the first molar tooth which will be treated. After removing of decay and broken filling, the tooth was built up to get four wall straight access cavity. Then, #10 K- file (MANI K files, Utsunomiya, Japan) was used to nigosiaste the root canals and check the canal patency. After that, radiographs, and apex locator (Root ZX mini, Morita, Japan) were used to determine the working length.

Glide paths reproduction were done by employing hand and rotary files # 10 K-file and Proglider file respectively and without coronal flaring. Then, cleaning and shaping started according to minimal invasive endodontic protocol by using ProTaper Next instruments (Dentsply Maillefer, Ballagues, Switzerland). the 'push-pull' preparation technique was used up to, X2 (0.25 mm tip with 6% taper) for mesial and buccal root canals of lower and upper first molars, and X3 (0.3 mm tip with 6% taper) for distal and palatal canals. Copious irrigation was performed with 2 mL 5% NaOCl following each protaper file with a recaptulation by #10 K-file.

Subsequently, laser irradiation was performed for smear layer removal by using Er,Cr:YSGG laser (Waterlase MD; Biolase Technology, Inc, San Clement, CA) at 2,780 nm wavelength with a radial firing tips RFT2 and RFT3 [diameter 200 μm for apical and middle third and 320 μm for coronal third respectively]. The running parameters were: 1.25 W, 20Hz, H Mode; Air 30; Water 10. The firing

tip was advanced inside the canal lumen 1mm shorter than the determined working length. Then, at the time of irradiation it would be withdrawan in a circular motion against the dentinal walls of the root. This operation was remade three times at a rate of 1-2mm/second.

After laser irradiation, a final irrigation was done with 5ml of Saline solution. Then, disinfection for the root canal was done with the same laser device, the same Steps were repeated in each canal but with disinfection settings; Tip: RFT2 and RFT3, 1.00W; 20Hz; H Mode; Air 10; Water 0.

The subjects were divided into two groups; the first one was obturated with carrier-based technique, while the second group filled with cold lateral compaction technique. AH Plus sealer (Dentsply Tulsa Dental Specialties, Tulsa, OK) was used in both groups.

In carrier-based technique, X2 or X3 Guttacore verifier was inserted inside the root canal down to the working length for size verification. Then, X2, X3 GuttaCore were used with the GuttaCore oven Thermanprep. (Dentsply Maillefer, Ballagues, Switzerland). Where as, in cold lateral compaction group, X2,X3 master gutta-percha cones (Dentsply Maillefer, Ballagues, Switzerland) was used with an accessory cones (0.02 taper).

After completing the obturation procedure, a light cured composite was used to seal the floor of the pulp chamber. Then, final restoration for patients have been done.

Outcome Measures and Criteria

Healing of the different apical periodontitis cases was evaluated clinically and radiographically along six months period. The clinical part of estimation depends on the signs and symptoms. While, the other part builds upon Periapical index (PAI) scoring. This scores graded from normal periradicular tissue which assembled by score 1 to severe apical periodontitis with exacerbating features which assembled by score 5 (15).

According to the above evaluation, three conditions of the study cases could be distinguished : healed, healing, or diseased (15,16). These conditions can be explained as the following:

A. Healed: normal status clinically, no tenderness to percussion, and the periapical index score 1 or 2 (assessed radiographically).

B. Healing: normal status clinically, no tenderness to percussion, and there is a decrease in the size of the apical periodontitis lesion or the PAI score shifted to smaller score.

C. Diseased: signs and symptoms present clinically, and the periapical index score 3 or more or there is a broadening in the volume of the apical periodontitis lesion or hiking in the PAI score

In summery, succeeded cases includes healed or healing conditions which accompanied the success of root canal treatment.

Evaluating Radiographs

The evaluation of the coded radiographic films of randomized different patients was performed blindly by two skillful endodontists. Firstful, a PAI score was given for every root which could be seen on the radiographic film. Then, the maximum index score of all tooth's roots was given for this tooth. The sum of these PAI scores of all teeth at different follow up periods was further statistically evaluated.

Statistical Analysis

SPSS version 21, was used to evaluate differences, two variables comparisons via independent t-test, three and more variables comparisons via Univariate (ONE WAY ANOVA) test. Pearson coefficient was performed to determine association of therapy outcome with studied variables. Detection of predictors was observed by using Logistic regression. Differences between variables were setting as significant at 5% ($P \leq 0.05$) and highly significant at 1% ($P \leq 0.01$).

The frequency, percentage, and the P-value of variables were tested. Among the forty participant in this study, 45% and 55% were male and female respectively, without statistically significant differences established between them. The percent of having a history of diabetes disease was 15%, with significant P-value ($P < 1\%$).

No significance was found between the different status of oral hygiene, 42.5% of the subjects had good oral hygiene and 57.5% was fair. After six months follow up, 32 of treated cases considered as healed, 17 cases under healing process, and the remaining one case was diseased as showed in Table 1 .

RESULTS

Table (1) Domains and sub-domains variables of study and their criteria of comparison.

Variables	Criteria	n (%)	P value
Age	≤ 35	29(72.5)	0.000**
Gender	Male	18(45)	0.988ns
Oral hygiene	Good	17(42.5)	0.613ns
Molar	upper left	11(27.5)	0.439ns
	upper right	6(15.0)	
	lower left	7(17.5)	
	lower right	16(40.0)	
Diabetic	yes	6(15)	0.000**
Periradicular diagnosis	Asymptomatic Apical	14(35)	0.065ns
	symptomatic Apical	8(20)	
	Acute Abscess	7(17.5)	
	Chronic Abscess	11(27.5)	
Sealer extrusion	yes	18(45)	0.988
Obturation type	Cold Lateral	20(50)	1.00ns
	Guttacore	20(50)	
Number of Visit	single	40(100)	
PAI score	≥ 3	40(100)	
PAI after one month	≥ 3	40(100)	
PAI after three month	≥ 3	29(72.7)	0.000**
PAI after six month	≥ 3	8(20)	0.000**
Healing rate	Success	39(97.5)	
	Healed	32(80)	
	Healing	17(17.5)	
	Diseased	1(2.5)	

ns= not significant, ** Significant differences at 1%,

Figure 1 presents radiographs of an endodontic case treated by Er,Cr:YSGG laser. The preoperative radiograph shows distal root with a well localized periapical

lesion. The healing of this lesion is revealed after 1 month, 3month, and 6 months afterwards endodontic therapy.

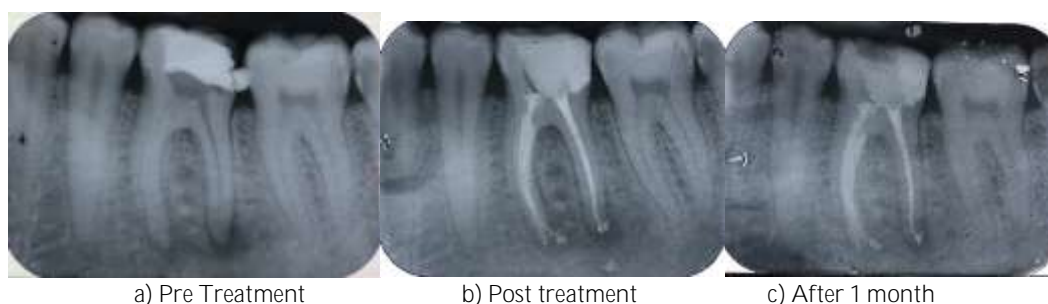




Figure 1. Radiographic films showing the roots of tooth #36. a) preoperative radiograph present a periapical lesion for both roots b)The mesial and distal roots were obturated with Gutta-core X2 andX3 respectively and AH Plus sealar. c,d,e) reveals the healing of the lesions at 1 month, 3 months, and 6 months after minimally invasive Endodontics therapy using Er,Cr:YSGG laser.

Moreover, as depicted in Table 2, concerning the Pearson correlations there is a highly correlation between the healing and the preoperative PAI score ($r = 0.543$ highly significant).

Table (2) Association of variables with the outcome

Variables	No	% Success	95% CI	Pearson correlation
Age			0.912-1.994	0.124ns
≤35	29	96.5		
>35	11	100		
Gender			-0.670 – 0.175	-0.189ns
Male	18	100		
Female	12	95.5		
Preoperative PAI score (≥3)	40	100	0.237- 0.726	0.543**
Obturation type			-0.670 – 0.170	-0.192
Cold Lateral	20	95		
Guttacore	20	100		

IC= confidence intervals, ns= not significant, * Significant differences at 5%, **Significant differences at 1%

The prognosis of healing rates was compared Temporally as shown in Figure 2. Forty patients were folowed up at three recall periods at 1-month, 3-month, and 6-month after treatment. The success of root canal treatment for these periods was 67.5%, 82.5%, and 97.5%, respectively.

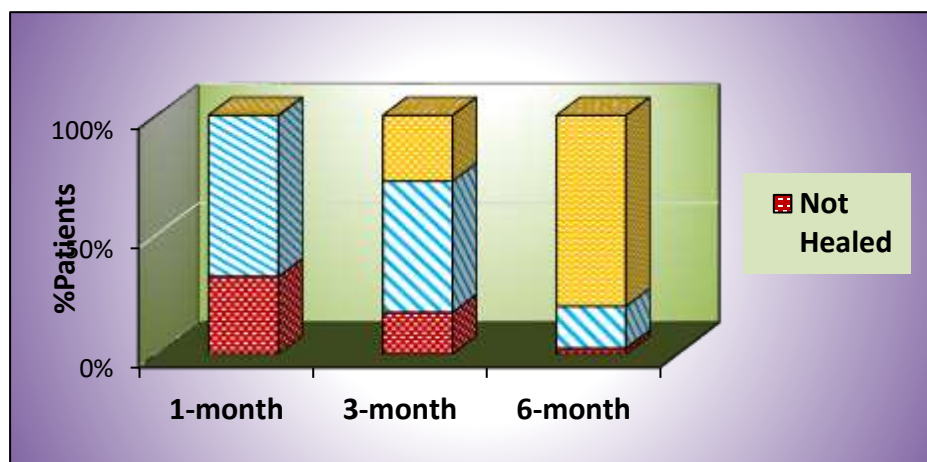


Figure 2. the success of therapy at 1-month, 3-month and 6-month follow-up time

DISCUSSION

The present study clarified the outcome of an endodontic treatment for 6-months follow-up. The treatment procedures of using Er,Cr:YSGG laser followed the Waterlase Endodontic Protocol (16). Moreover, the cleaning and shaping were performed according to minimally invasive technique to preserve the root

structure. The apical enlargement was from 0.25 mm to 0.3 mm with 6 % tapering, further decreasing of the apical diameter conflicts with the requirements of the obturation techniques.

Carrier based and lateral compaction obturation techniques were adopted for root canal obturation afterwards laser application. Earlier in vitro studies were

using the same laser after multiple appointments endodontic treatment, but the canals instrumented to a larger apical diameter (17,18,19). Their results depending on enlarging the canal size provide freely movement of laser tip inside the root canal space.

furthermore, there is no dependable confirmation that healing improvement affected by number of sessions, whatever it is single or multiple sessions with calcium hydroxide intracanal medication [7, 33].

One of the objectives of root canal therapy is to survive the involved tooth to the finest viable case without surgical intervention (20, 21). Some studies advocate that teeth with partial healing prognosis must be subsequent to prolong time duration. Despite that, another study (22) presents about 95% of the cases with long period follow up could be anticipated at shorter period. In addition, lost of patients susceptibility over long period follow-ups will be increased. So that, some of researchers directed to chose briefer follow up duration, while others recommended simpler but definite proxy endpoints [23, 24]. In this study, the patients were observed for 6 months period.

Earlier clinical researches (25,26,27) were done using other endodontic supported techniques. They present different healing percentage at the same endpoint period, after six months. One study present 70.6% healing percent of the lesion after root canal treatment(28). Other study (29) revealed healing percent around 67% of the treated cases. Another one showed 83.33 % healing rate after using of Er,Cr:YSGG laser (30).

In the present study, 97.5% healing rate at 6 months period was displayed. This result of high endodontic success reject the guesstimated hypothesis that the healing percentage checked at 6 months will be decreased.

In traditional root canal treatment, it is popular that the disinfection of the root canal especially the apical third could be promoted utilising ultrasonic tips (31). In the present study, the displayed result of 97.5% healing percentage signify a valuable laser elimination of the smear layer from dentinal wall. In addition ,to an efficient and thorough disinfection laser action underneath dentinal tubules.

One of the crucial factors that connected directly to the treatment success is the conservation of tooth dentine as much as possible (32). In the present study, it is noticeable that this issue is taken into account through using minimal invasive endodontics. The dentin structure is preserved during access preparation and root canal shaping.

In conclusion, the teeth of different apical diagnosis can be treated with the Er,Cr:YSGG laser. It showed a tremendous degree of success of root canal treatment in a period of 6 months after treatment. There is no significance between the obturation techniques (cold lateral or carrier based). The treatment results were anticipated in a period a few months. The Er,Cr:YSGG laser permit for rapid rate of healing with a predictable outcome .

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