Dentistry
ISSN: 2161-1122

Yu, Dentistry 2017, 7:12
DOI: 10.4172/2161-1122.1000463

Case Report | Open Access

Multiple Applications with Er:YAG Laser in Apicoectomy-A Clinical Case Report

Li-Ling Yu *

New Image Dental Office, Taipei, Taiwan

Abstract

An apicoectomy is usually performed after a failed root canal treatment.

During the operation, the infected tissue should be removed thoroughly, and the tooth should be examined with care. If the tooth is cracked or fractured, extraction will be recommended. Surgical endodontics could be performed using Er:YAG laser on patients exhibiting periapical pathosis. It has attracted attention because of the possibility of cutting hard and soft tissues with extremely minor thermal effects. Other benefits also include bactericidal effect, and biostimulation to increase wound healing by LLLT (Low Level Laser Therapy). All of the above could promise the best prognosis to patients and the best outcome to dentists.

In this article, all procedures were performed using Er:YAG laser (2940nm, LiteTouch Dental Laser, Light Instrument, Israel) with copious saline coolant under local anesthesia. The laser treatments included: incision and reflection of the mucoperiosteal flap, osteotomy over the lesion, removal of granulation tissues and gutta-percha fragments, root-end resection without retrofilling, and LLLT after wound sutures. The clinical condition of the patient was evaluated at 1 week, 1 month, and 3 months after surgery. No adverse reactions were seen during the laser irradiation procedure, and radiolusency lesion area was smaller and more opacity at 3 month checks. It is concluded that apicoectomy using Er:YAG laser would offer another option for dentists and patients to save the problematic tooth. However, improvement of the laser device and more education for dentists and patients may afford considerable advantages.

Keywords: Apicoectomy; Er:YAG laser; Gutta-percha fragments; LLLT

Introduction

The therapeutic goal of each root treatment has to be decontamination of the root canal and accessory canals, along with the dentinal tubules. Also, the periapical tissues have to be included, in case they are involved. A mixture of gram-positive and gram-negative anaerobes mainly causes root canal infection. Bacteria and their toxins that spread from the root canal and contaminate the apical region cause inflammation, infection and bone resorption.

An apicoectomy is usually performed after a failed root canal treatment. During the operation the infected tissue is removed, and the tooth should be examined at the same time. If the tooth is cracked or fractured, extraction will be recommended [1]. The conventional approach in apicoectomy is to make an incision with a scalpel and then use a periosteal elevator to lift a flap. Remove the granulation tissue with hand instruments, root apex is reshaping by rotary instruments. But it is difficult to remove residual biofilms that only depend on chemo-mechanical debridement.

Most reports have indicated that laser irradiation is useful for bacterial reduction [2]. The Er:YAG laser emitting light at 2940 nm has been reported to control bacteria in the root canal including periapical area. And Er:YAG laser also has the potential to cut hard tissues without significant thermal or structural damage [3]. Multi-applications with Er:YAG laser in apicoectomy was based on many studies of Takahide Komori, et al. [4], Keller's, Buchelt's, etc. [5,6]. Using laser treatments for this case can reduce pain during treatments, aid in hemostasis for improving visibility during the surgical procedure, less scar formation in the wound area, and improve prognosis due to bacterial reduction and biostimulation of low-level laser therapy.

Case Presentation

A 32-year-old healthy female presented with chief complain of #11 crown fractured and wanted to be reconstructed with #11and#21 due to one unit of two porcelain crowns was constructed. Clinical intraoral examination showed that porcelain crown of #11 incisor edge was fractured and a fistula near apex area of #21 was noted, #11 and #21 were stable with no mobility (Figure 1). Then the patient was checked with #11, #21 apical film. It showed radiolucency over apex of #21 and some gutta-percha fragments were noted (Figure 2). The diagnosis was apical resorption [inflammatory].

In this article, all procedures were performed by using Er:YAG laser [2940nm, LiteTouch Dental Laser, Light Instrument, Israel] with copious saline coolant under local anesthesia.

Laser Treatments

Step 1. Laser scaling

The setting was 50 mJ/10 Hz with 100% of water for full mouth laser scaling and then ultrasonic scaling tip was used for supragingival scaling. In addition, another laser setting was applied at 50 mJ/30Hz with 100% of water for subgingival sterilization and then ultrasonic round tip was used for subgingival curettage [7,8].

Step 2. Vertical soft tissue incision

The setting was 100 mJ/40 Hz with 100% of water for incision [in vestibular near apex of #21] (Figure 3).

Step 3. Granulation tissues ablation

The setting was 400 mJ/15Hz with 100% of water. Granulation tissues were ablation thoroughly (Figures 4 and 5).

***Corresponding author:** Li-Ling Yu, DDS MS, New Image Dental Office 1F, No.147-149, Sec. 2, Anhe Rd. Taipei City, Taiwan, Tel: +886-919 386 696; E-mail: enlin.fr68@msa.hinet.net

Received May 15, 2017; **Accepted** October 31, 2017; **Published** November 07, 2017

Citation: Yu LL (2017) Multiple Applications with Er:YAG Laser in Apicoectomy-A Clinical Case Report. Dentistry 7: 463. doi:10.4172/2161-1122.1000463

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Figure 1: The intraoral examination showed a fractured crown of #11and a fistula through root area around #21.

Figure 2: Apical film showed: radiolucency over apex of #21 with some gutta-percha fragments.

Step 4. Bone removed

The setting was 200 mJ/50Hz with 100% of water for osteotomy. Necrotic bone and gutta-percha fragments were removed (Figure 6) [9,10].

Step 5. Root end resection without retro filling

The setting was 250 mJ/50Hz with 100% of water.

Figure 3: Photo showed: Incision with Er:YAG laser (LiteTouch, Syneron).

Figure 4: Photo showed: Granulation tissues ablation.

Figure 5: Apical film showed: little gutta-percha fragment was still noted.

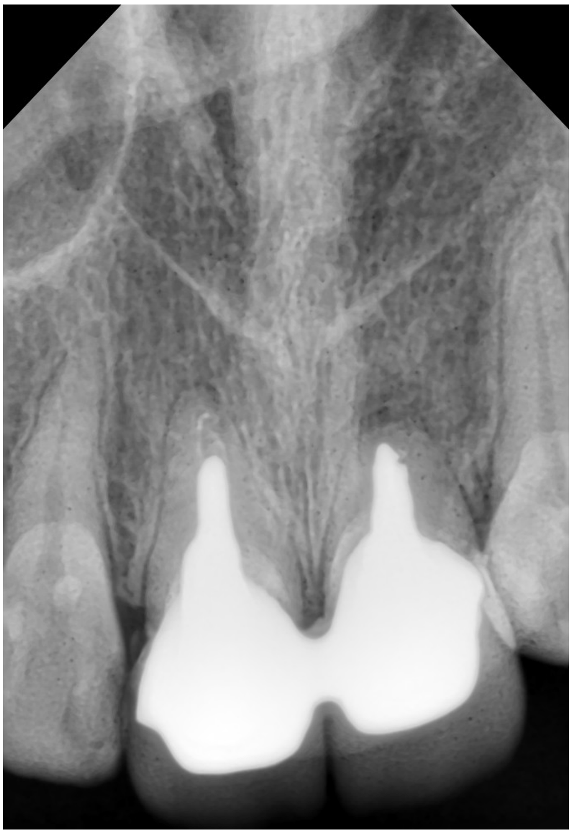

Figure 6: Apical film showed: the wound area was very clear.

Step 6. Coagulation and biostimulation

After wound sutured with silk, the setting of coagulation was performed with 50 mJ/10Hz [no water] and the biostimulation was also performed with 50 mJ/10Hz [100% of water] of increasing wound healing. The symptoms and signs were significantly subsided and greatly relieved the day after laser treatments. The patient experienced no pain during the course of laser treatments. The clinical condition of the patient was evaluated at 1 week, and 3 months after surgery (Figures 7 and 8).

Figure 7: Photo showed: one week after treatment. Prognosis was good after treatment.

Figure 8: Photo showed: three months after treatment.

Discussion

The fundamental aim of endodontic therapy is to remove microorganisms and all inflammatory irritants. Since the existence of a three-dimentional complex network, accessory canals, anastomosis, and dentinal tubules makes sterilization of the root canal virtually impossible. Although most of follow-up studies on endodontic therapy were reported overall success rate of 85% to 90%, the main cause of root canal therapy failure being persistent microorganisms [11,12]. Enterococcus faecalis is one of the most resistant microorganisms found in case of failed root canal therapy [13-15]. It is difficult to remove the smear layer, creating condition for the formation of E. faecalis biofilm, in periapical region by using current routine endodontic procedures that depend on chemo-mechanical debridement. This led to search for better methods.

Apicoectomy is associated with mucoperiosteal flap elevation, followed by osteotomy, to approach the periapical region. Root-end cavity preparation and retrograde filling are often performed in the surgical procedure [16]. There were numerous techniques and instruments to be recommended and evaluated in literatures, for obtaining the ideal method in apical surgery [17,18].

Hibst and Keller [19] reported that under sufficient water cooling, cavities could be made in enamel and dentin with an Er:YAG laser without causing thermal damage to the surrounding tissue. Scanning electron microscopic [SEM] studies by these authors showed that laser-resected surfaces presented an irregular but clean surface, with no smear layer and exposed dentinal tubules. Laser resection and cavity preparation offered the added benefit of disinfection of the root surface and the root-end cavity, also reported in Aziz A., and Chandler, et al. [20].

The application of dental laser is increasingly popular in the endodontic field, and many studies have been demonstrated for their use [21]. Most reports have indicated that laser irradiation is useful for bacterial reduction [22]. Only lasers with a wavelength that can penetrate dentine to a depth that can eliminate bacteria are applicable. However several types of laser systems have been used for endodontic treatment, namely Nd: YAG, CO2, He-Ne, GaAlAs, Er:YAG, Er, Cr: YSGG lasers each of which is characterized by a different wavelength [23,24].

Indications [25] for laser-supported endodontis can be used in the follows:

- Chronic apical parodontitis
- Acute apical parodontitis
- Purulent pulpitis and pulp necrosis
- Gangrenous pulpitis
- Periapical abscess: The bactericidal effect of the laser guarantees secure and fast therapy success.
- Apical resorption [inflammatory]: With lasers, the apical resorption area can be irradiated and the inflammatory process stopped.
- Therapy-resistant long-term failure
- Combined periodontal-endodontic pathology
- Partly sclerosed canals: The high penetration depth of the laser reaches bacteria even in cases where the mechanical preparation has to stop 2-3 mm above the apex.

Er:YAG laser has a high potential for ablating hard tissues with less heat because of their high water absorption characteristic compared with CO2 and Nd:YAG laser [26]. Therefore, the threshold of their bactericidal effect is expected to be much lower than those of other high-power lasers. The antibacterial effect of Er:YAG laser is effective but restricted to a small area surrounding the root canal [27].

Er:YAG laser is much better then Er, Cr:YSGG in highly absorbed by water and hydroxyapatite. When irradiated, water contained in the dental hard tissue evaporates instantaneously and thereby ablates the surrounding tissue. It has attracted attention because of the possibility of cutting hard and soft tissues with extremely minor thermal effects.

When disinfection is difficult with routine infected root canal treatment, anti-biofilm [28] and antimicrobial procedures with an Er:YAG laser is expected to be beneficial [29,30]. In the article of Lasers Med Sci [2008] 23:415-420 H. D. Arisu, et al. [31] discussed about SEM observations between conventional group and laser-irradiated groups. The anti-biofilm actions of Er:YAG laser might be due to absorption of water in biofilms, and small numbers of residual viable cells might undergo thermal necrosis. When desired, reducing the energy density of Er:YAG laser can also be achieved by using in a defocused mode and regeneration, thus biostimulation is not a thermal effect [32].

The advantages of Er:YAG laser applications for apicoectomy include the following: the possibility of cutting hard and soft tissues with extremely minor thermal effects, the bactericidal effect of the laser guarantees secure [33] and fast therapy success, absence of vibration discomfort [because of noncontact method], and the biostimulation to increase wound healing by LLLT [34].

All of the above could promise the best prognosis to patients and that will be available. No adverse reactions were seen during the laser irradiation procedure, and radiolusency lesion area was smaller and more opacity after 3 months checks.

At energy levels [measured in mW] incapable of tissue removal, the stimulation of cellular metabolism known as low-level laser therapy [LLLT] or photobiomodulation [PBM] [35]. Providing laser treatment at low energy levels can be useful and beneficial for healing and regeneration, the predominance of literature suggests that LLLT occurs with visible and near-infrared wavelengths from 633 to 904nm[36-38]. Diode laser would be better for biostimulation due to less wavelength than the Er:YAG Laser.

There were another options for application with Er:YAG combined with Nd:YAG [in Step 5 plus Root-end sterilization with Nd:YAG] or Diode Lasers in apicoectomy [39,40]. The reason for application Nd:YAG laser in root-end sterilization is that the effects of Nd:YAG laser on the permeability of dentine following apicoectomy appear to reduce the permeability of resected roots [41].

Conclusion

It is concluded that multi-applications with Er:YAG laser in apicoectomy would offer another option for dentists and patients to save the problematic tooth. Combined with Nd:YAG or Diode laser may also provide another option based on the condition of the case result and prognosis. However, improvement of the laser device and more education for dentists and patients may afford considerable advantages.

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