Apicectomy of an endodontically compromised central incisor

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The following article presents a case of Er:YAG laser-assisted surgical removal of a fractured endodontic instrument from the periapical region of a maxillary central incisor.

Introduction

Fracture of endodontic instruments in the root canal is one of the most troublesome incidents in endodontic therapy. It is reported that the prevalence of fractured instruments is between 0.5 and 5.0 per cent.[1] Endodontic instruments rarely separate beyond the apical foramen. The fractured segment is a foreign object and might cause inflammation.[1] Moreover, patients often regard the fractured segment as a broken needle and suffer psychologically. Thus, an attempt to remove these objects through surgery is often necessary.[1]

Apicectomy is an alternative approach to surgical endodontic therapy. It entails removing periapical inflammatory tissue, followed by apical resection and retrograde filling of the root canal. Such procedures are performed using a trans-osseous approach. The success rate of the apicectomy procedure is above 91 per cent.[2] Moreover, new techniques are being introduced constantly, with many including the use of Er:YAG lasers.[3,4]

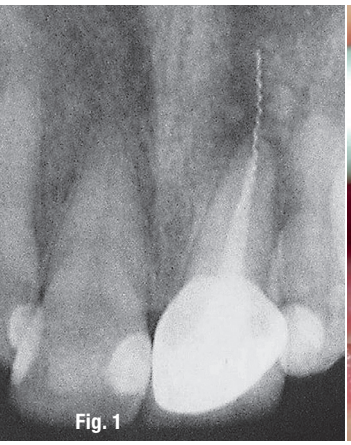


Fig. 1

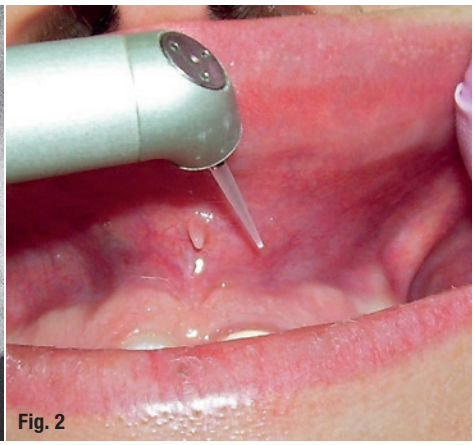


Fig. 2

Fig. 1: Irretrievable separated instrument in the root canal. The separated instrument only required surgical intervention because the tooth was symptomatic. At presentation: a radiolucent area near the separated instrument at the apex of tooth #21. **Fig. 2:** Semilunar incision with the Er:YAG laser (in contact mode).

It is important to recall the principles of endodontic surgery that dictate treatment. The prime considerations may be summarised as follows:[4]

- A thorough appreciation of the surgical anatomy is of primary importance in order to carry out a well-performed procedure. An adequate radiographic investigation must precede the surgery in order to properly assess the lesion and the associated anatomical structures.[4]
- The preferred mucoperiosteal access is through a semilunar incision, which must always be positioned above the lesion and never through the lesion itself.[4]
- The surgeon needs to have both experience and a good surgical technique.[4]
- Associated granulation tissue or more organised periapical pathology must be thoroughly removed.[4]
- The root apex must undergo appropriate resection in order to eradicate the apical tip and any accessory root canals in this region. Wherever possible, the resection level should be coincident with the buccal or labial alveolar bone level.[4]
- It is considered appropriate that a retrograde root canal filling should be performed routinely during apical surgery. The purpose of the retrograde filling is to seal the exposed root canal and prevent leakage of pathogens into the periapical area. Isolation of the root area is vital during this procedure and will enhance a successful outcome.[4]

New techniques, materials and technologies can be used to increase the already high success rate of periapical surgery. Treatment with an Er:YAG laser is considered an alternative that bears many advantages.[3–6]

Using the Er:YAG laser in apicectomy surgery

Features of Er:YAG laser-assisted surgery with specific regard to apicectomy procedures are:[4]

- The Er:YAG laser has a wavelength of 2,940 nm. The prime chromophore of this laser wavelength is water, which makes it appropriate for ablating both hard and soft oral tissue.
- The Er:YAG laser can perform incisions for flap lifting, such as a crestal incision, an intrasulcular or vertical releasing incision, or semilunar incision. The laser produces a wet incision (there is some bleeding).

- Ablation of granulation tissue after raising a flap is efficient with the Er:YAG laser, posing a lower risk of overheating the bone.
- Lasing directly on the bone achieves detoxification of the infected site. Studies have shown that Er:YAG laser energy effects on bone cause bacterial reduction.
- The Er:YAG laser can be used for ablation of alveolar bone tissue—remodelling, shaping and ablation of necrotic bone.
- The Er:YAG laser can be used for root apex resection in contact mode and for preparation of the apex cavity for retrograde filling.
- Although studies into the use of the Er:YAG laser in clinical bone surgery procedures have reported inconclusive subjective advantages in terms of time required, postoperative pain levels or ease of access, histological investigations have demonstrated better levels of early healing of the bone with the laser compared with the surgical bur and piezoelectric surgery.

This article presents a case in which an Er:YAG laser was used successfully to remove an endodontic instrument fractured beyond the apical foramen.

Case report

A 28-year-old female patient came to the practice complaining about periodic episodes of pain associated with the maxillary right central incisor. The patient's general medical history was uneventful and she was not taking any medication. Upon examination, the tooth had been restored with a porcelain-fused-to-metal crown. Her general level of oral health was good, owing to adequate oral hygiene. In addition, the periodontal condition was good, with no pocketing or bleeding on probing. Periapical radiographic examination showed a fractured instrument (lentulo) beyond the root canal and a radiolucent area around the apical portion of the root canal (Fig. 1). A diagnosis of periapical granuloma due to failure of the orthograde root filling complicated by a fractured instrument beyond the apical foramen was made, and treatment indicated surgical curettage of the area and apicectomy.

Treatment protocol

A fibreless laser system with an operating wavelength of 2,940 nm (LiteTouch, Light Instruments) was employed for this procedure, following the protocol described by Dr A. Reyhanian.[4] Treatment alternatives included the use of a conventional scalpel, curettes and rotary instruments.

The laser operating parameters employed for the various surgical stages were as follows:
- Releasing incision of the flap: contact mode, 200 mJ, 35 Hz; 0.4 × 17.0 mm tip.
- Bone removal to expand the entrance to the apex: non-contact mode, 300 mJ, 35 Hz; 1.3 × 19.0 mm tip.

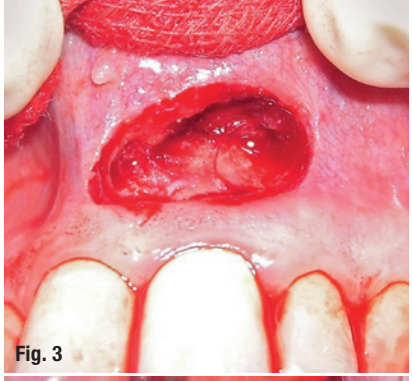


Fig. 3

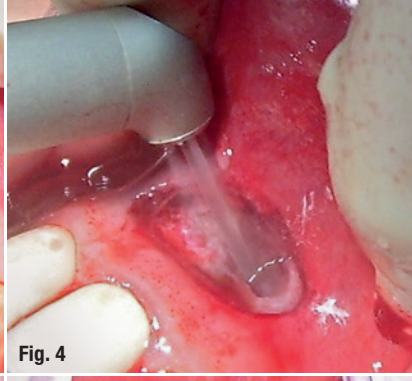


Fig. 4

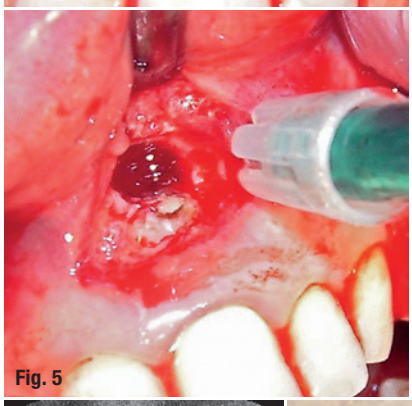


Fig. 5


Fig. 6

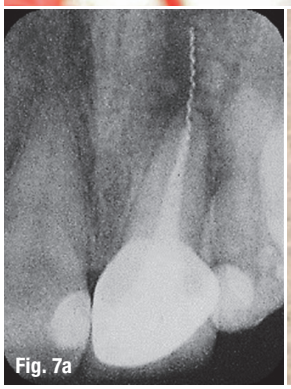


Fig. 7a


Fig. 7b

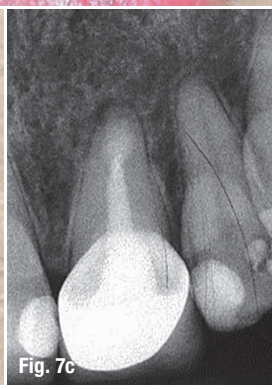
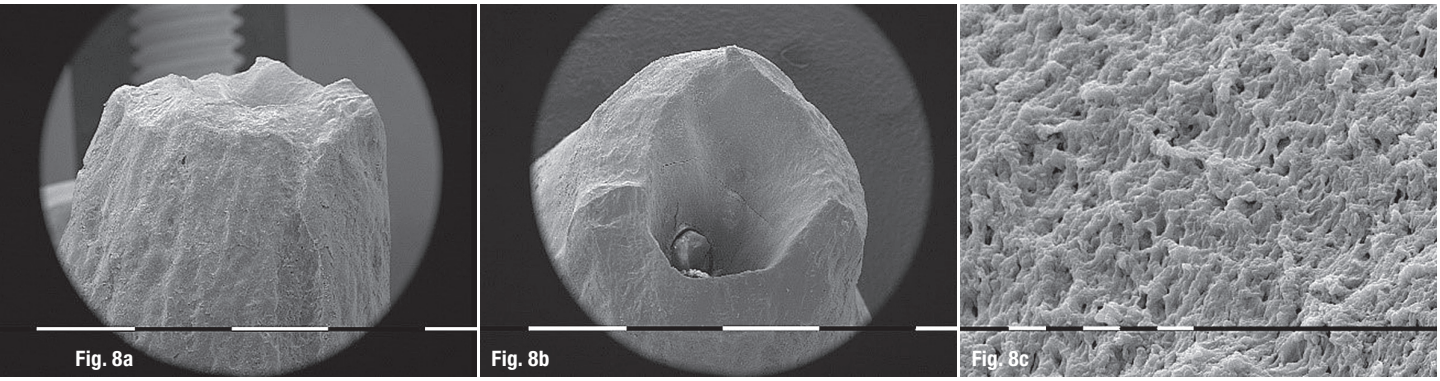


Fig. 7c

Fig. 3: Raising the flap. **Fig. 4:** Expanding the entrance to the lesion with the Er:YAG laser in non-contact mode. After removal of the compact bone, the fractured instrument was exposed and could be removed easily. The next step was granulation tissue removal and bone cavity disinfection. **Fig. 5:** Using the Er:YAG laser to cut the apex and to prepare the apex cavity for retrograde filling (in non-contact mode). **Fig. 6:** Primary closure. **Figs. 7a–c:** The radiograph before treatment **(a)**. The removed separated instrument **(b)**. The radiograph after one year revealed a completely healed bone defect with no signs of bone resorption **(c)**.

- Ablation of granulation tissue: non-contact mode, 400 mJ, 15–20 Hz; 1.3 × 19.0 mm tip.
- Resection of the root apex: non-contact mode, 400 mJ, 20 Hz; 0.8 × 14.0 mm tip.
- Retrograde cavity preparation: non-contact mode, 400 mJ, 20 Hz; 0.8 × 14.0 mm tip.

A semilunar incision was made after administering infiltrative anaesthesia. The incision extended from a point approximate to the distal area of the maxillary right lateral incisor to the distal area of the maxillary left central incisor (Fig. 2) and the flap was elevated (Fig. 3). A small fenestration of the labial bone was performed and surrounding bone was ablated in order to expand the entrance to the defect. After the removal of the compact bone, the fractured instrument was exposed and removed easily. A large quantity of granulation tissue was ablated using non-contact mode (Fig. 4).



Figs. 8a–c: SEM evaluation at different magnifications showing a root apex resected with an Er:YAG laser **(a)**, a prepared retrograde cavity **(b)** and root dentine inside the cavity with absence of a smear layer and of cracks **(c)**.

After removal of the fractured instrument, the root apex was sectioned. The Er:YAG laser energy produced a smooth, clean resection without visible signs of thermal damage. At the same power setting, the cavity of the apex was prepared for retrograde filling. Finally, the bone defect was shaped and remodelled. The retrograde cavity was sealed with mineral trioxide aggregate (MTA, Fig. 5). MTA has been recommended for root end filling during endodontic therapy and presents advantages such as easy placement, a hydrophilic nature, a lack of toxicity and low solubility. The flap was sutured with a 3/0 silk thread, with careful attention to good primary closure (Fig. 6). The patient was prescribed amoxicillin (500 mg/8 hours) for seven days and ibuprofen (600 mg/8 hours) for three days. After seven days, the patient was recalled to have the sutures removed. The swelling had resolved and healing was progressing well. After six weeks, the soft tissue had completely healed without complications. The radiographic examination after one year revealed a completely healed bone defect with no signs of resorption. The prognosis was considered excellent (Fig. 7).

Discussion

This case report has described the use of an Er:YAG laser for apicectomy, emphasising the advantages of this laser wavelength in performing an apicectomy versus conventional methods. The use of the Er:YAG 2,940 nm laser has been shown to be effective in the surgical ablation of tooth tissue and bone.[3,4] Advantages of this modality over conventional rotary instrumentation may include precision, bacterial decontamination, less collateral damage, and tactile stimulation.[3,4] In addition, although studies have been equivocal, the use of this laser in surgical procedures may result in less fatigue of the surgeon and greater patient acceptance.[3,4,6] What has been demonstrated is an enhanced early healing response in bone tissue and a lesser level of postoperative complications.[6]

In addition to these clinical observations, we have studied the apical surface characteristics and presence of dental cracks in extracted single-rooted human incisors, resected 3.5 mm from the root apex using the Er:YAG laser, a stainless-steel bur and a diamond-coated ultrasonic tip, respectively, by scanning electron microscopy (SEM, Fig. 8). The SEM images showed that the stainless-steel bur produced significantly smoother resected root surfaces than did the diamond-coated tip and Er:YAG laser. There was no statistically significant difference between the Er:YAG and diamond-coated tip groups. However, the analysis of scores obtained for the cut quality according to the Kruskal–Wallis test revealed no significant differences among the groups. More importantly, in our study, Er:YAG-treated teeth had no cracks after the apical resection, unlike the other two groups. Photomicrographs of the Er:YAG laser group revealed exposed dentinal tubules after resection in contrast with the stainless-steel bur group (a heavy smear layer) and the diamond-coated ultrasonic tip group (a thin smear layer). To sum up, it can be stated that the Er:YAG laser produced better apical root surfaces than did the diamond-coated ultrasonic tip or stainless-steel bur. Within the limitations of this *in vitro* study, we can also conclude that the diamond-coated tip provoked a larger number of cracks compared with the Er:YAG laser.

Conclusion

The outcome of this clinical case indicates that the use of the Er:YAG laser should be considered an alternative, suitable and useful method for performing an apicectomy. It has been shown to be effective and safe.

Literature

contact

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