

Laser enucleation of a radicular cyst with the PIPS protocol

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Introduction

The most frequent odontogenic cyst in tooth-bearing areas is the radicular cyst, also called a periapical cyst.^{1,2} It arises from epithelial cell rests of Malassez in the periodontal ligament as a result of inflammation.^{3,4} Radicular cysts may be seen with irreversible pulpitis, root fracture, periodontal disease and apical periodontitis, and with or without fistulae. The diagnosis is usually made on the basis of anamnesis, clinical investigation and a radiograph or cone beam computed tomography (CBCT) scan.⁵ Enucleation is defined as the complete removal of the cyst by separating the cystic lining from the inner bony surface. Although small cystic lesions frequently heal with endodontic therapy only, larger lesions may need additional treatment. Untreated cysts may expand, causing local tissue destruction and deformities.

The treatment of choice depends on the size and location of the lesion, the bone integrity of the cystic wall and the cyst's proximity to vital structures. Cysts are usually enucleated and removed and the cavity allowed to fill with blood to form a clot.^{1,2} The aim of enucleation of a cyst is to remove all of the cystic tissue, disinfect the area and finally allow the bone tissue to fill the cavity with new bone. The location of the cyst could make these clinical steps difficult to achieve. In addition, the ability to successfully remove the smear layer and bacteria continue to be a challenge in intrabony infections.^{3,4}

The use of the Er:YAG laser is promising for reduced risk of recurrence and improved healing, depending on the ability to disinfect the surgical area and remove the smear layer. Therefore, the aim of using the Er:YAG laser in this study was to achieve atraumatic cleansing of the extraction sockets and cystic cavity, as well as disinfection of the area and removal of the smear layer, during the cyst enucleation for better and faster healing.

Materials and methods

Medical and dental history

A 38-year-old white male presented for dental treatment. He suffered from diabetes, which was under medical control, however. He reported no allergies. The patient

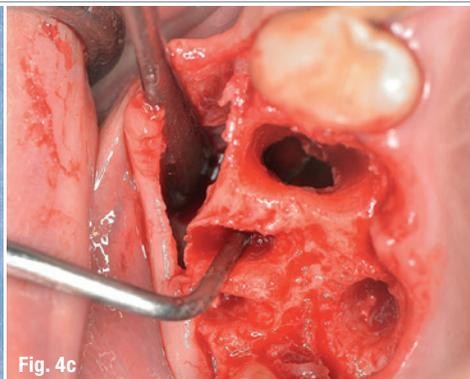
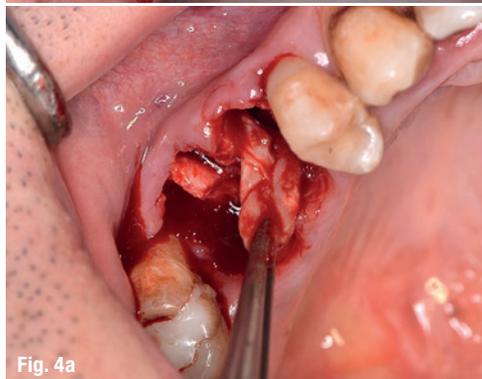
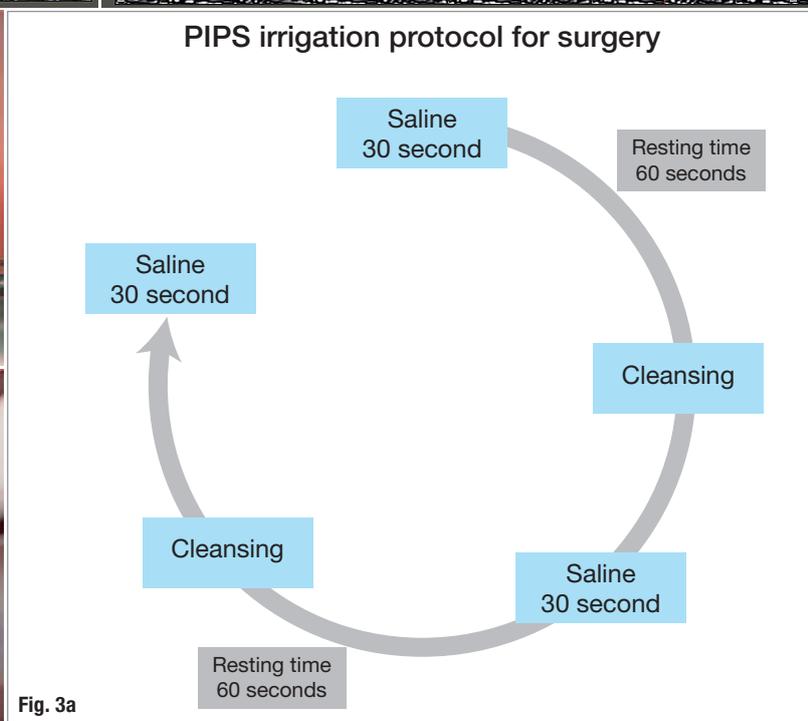
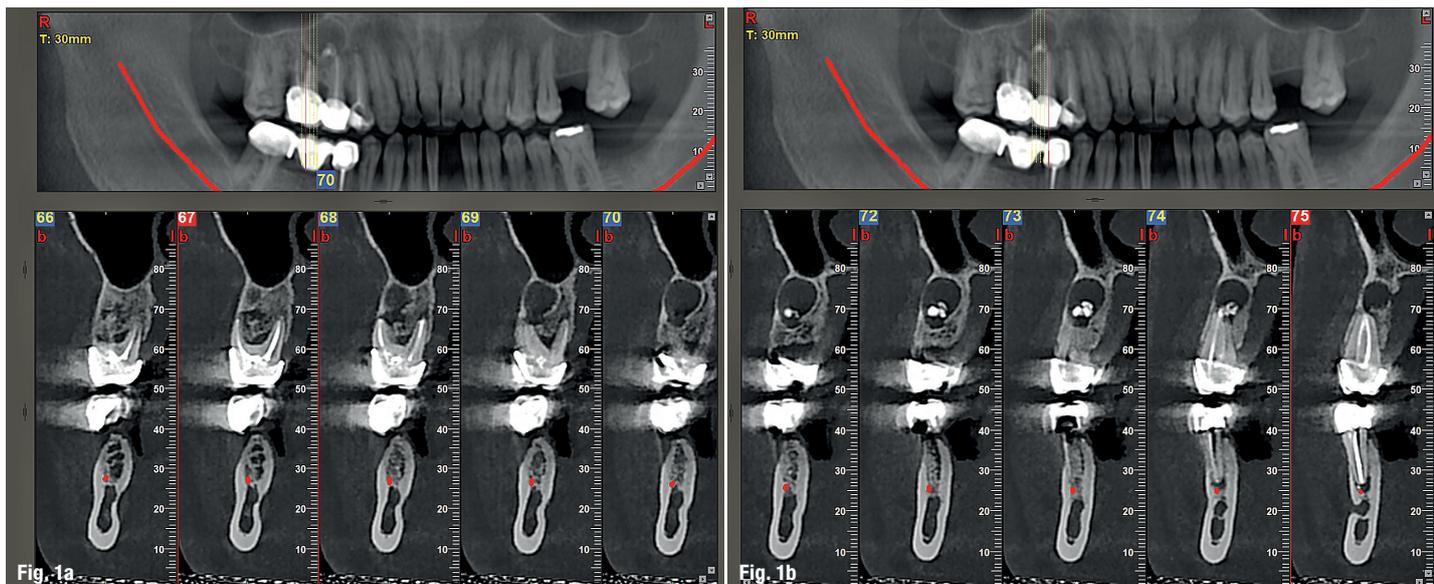
complained of a fractured maxillary right molar. Radiographic (CBCT) examination was performed. The radiograph confirmed that teeth #15 and 16 had previously undergone root canal therapy. The patient was diagnosed with a radicular cyst at teeth #15 and 16 below the maxillary sinus (Figs. 1a & b). The treatment plan included extraction of the teeth, enucleation of the cyst without perforating the maxillary sinus, and follow-up treatment.

Treatment

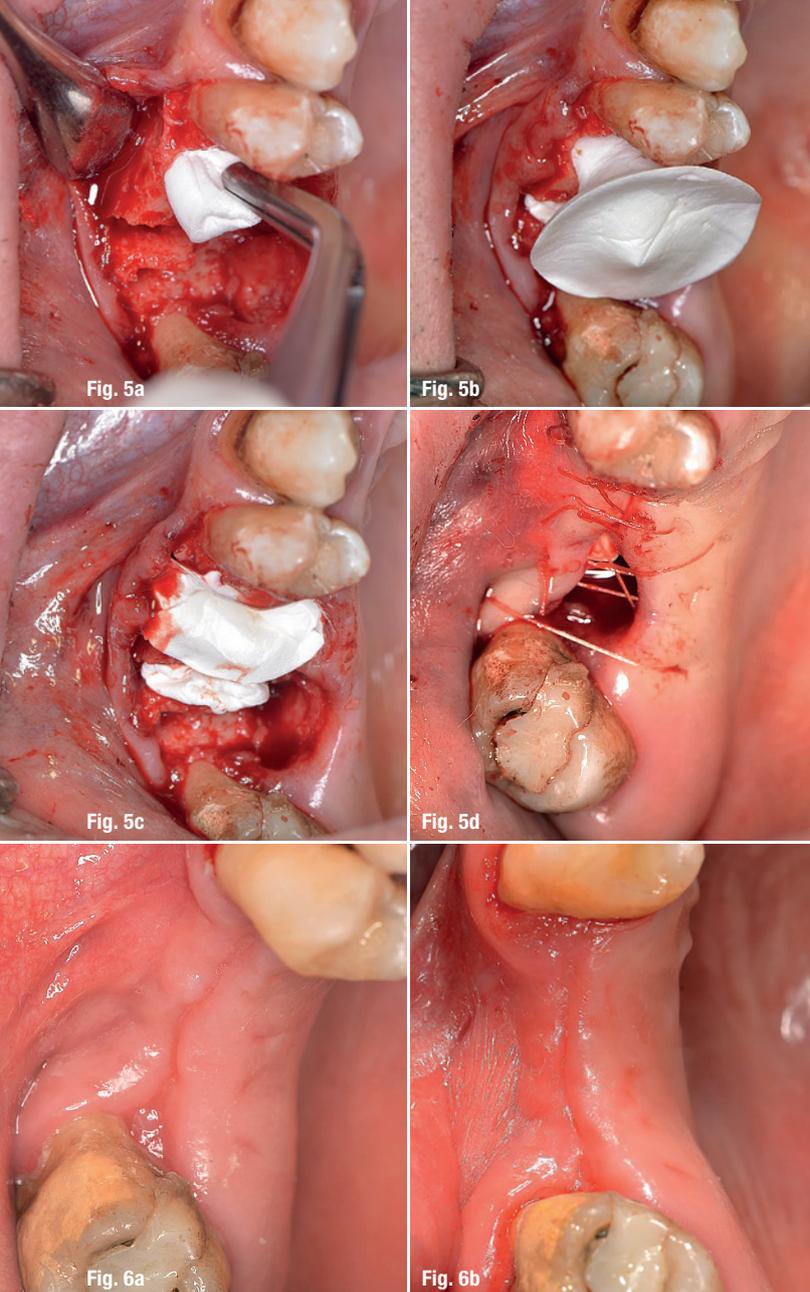
It was planned to follow the extraction of the teeth by irradiation with an Er:YAG laser for removal of granulation tissue in the extraction sockets and enucleation of the cyst. A collagen barrier membrane would be used thereafter to aid healing of the cystic cavity. After extraction, an Er:YAG laser with a wavelength of 2,940 nm (LightWalker, Fotona) was used to irradiate the extraction sockets. First, removal of granulation tissue was performed with a cylindrical tip, using the following parameters: 150 mJ per pulse, 20 Hz, short pulse duration, water spray setting 6 and air spray setting 3 (Fig. 2). A modified PIPS (photon-induced photoacoustic streaming) irrigation protocol was then performed for enhanced removal of residual cystic tissue (Fig. 3a). A quartz PIPS fibre tip of 9 mm in length and 600 µm in diameter was used. The tip, as received from the manufacturer, was tapered and had 3 mm of the polyamide sheath stripped back from its end.⁶ The following laser operating parameters were used: 40 mJ per pulse, 15 Hz and 50 µs pulse duration (super-short pulse). The coaxial water spray feature of the handpiece was set to "off". The tip was placed into the extraction socket and used under constant saline irrigation (Fig. 3b). The cyst was enucleated (Figs. 4a–c) and the cystic cavity was checked for residual granulation tissue. Augmentation of the cystic cavity was performed using a collagen barrier membrane and the cavity was subsequently sutured (Figs. 5a–d). After the procedure, a postoperative analgesic and antibiotics were prescribed, and the patient was instructed on continuing care at home.

Results

No complications arose during or immediately after the laser-assisted surgical treatment. Follow-up visits were scheduled at one week, three months and nine months postoperatively. At the first follow-up, the healing process



Figs. 1a & b: Radiographic (CBCT) examination revealed a radicular cyst at teeth #16 (a) and 15 (b). **Fig. 2:** Removal of granulation tissue from the extraction socket. **Figs. 3a & b:** Modified PIPS irrigation protocol for cyst enucleation from a deep extraction socket (a). Thirty seconds of PIPS irrigation with saline followed by a 60-second resting phase and degranulation until successful cyst enucleation was achieved (b). The procedure can be repeated if necessary. **Figs. 4a–c:** The cyst was successfully enucleated (a & b) from the cystic cavity (c).



Figs. 5a–d: Cystic cavity augmentation was performed using a collagen barrier membrane (a–c) and sutured (d). **Figs. 6a & b:** At the three- (a) and nine-month follow-ups (b), the soft tissue had healed nicely.

appeared uneventful. At the three- and nine-month follow-ups, good complete soft-tissue healing had occurred (Figs. 6a & b). Control radiographs were taken. At the three-month follow-up, hard-tissue healing was progressing naturally (Figs. 7a & b). At the nine-month follow-up, the hard-tissue healing was complete (Figs. 8a & b). The patient was then referred for further dental treatment needs, including implant therapy, and monitoring through follow-up appointments was planned.

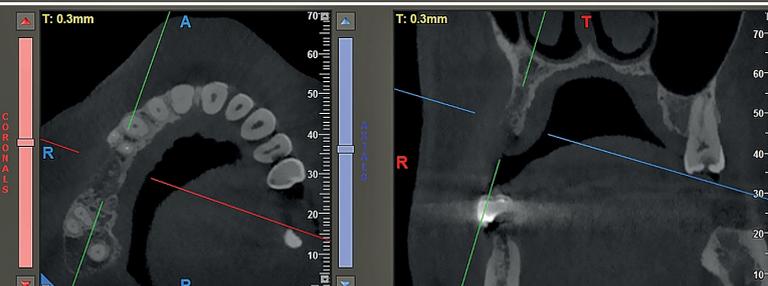
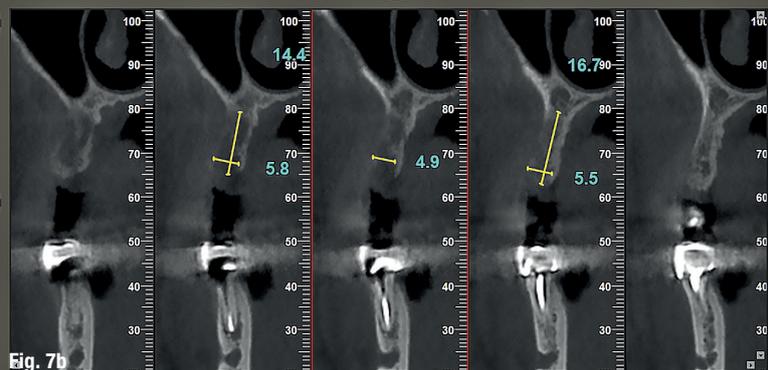
Discussion

The adequate treatment of cysts is still a matter of much discussion. Various treatment options have been suggested, depending on the size and location of the cyst. While for large lesions, endodontic treatment is followed by surgical enucleation, some authors have proposed non-surgical management of small lesions. In this case,

however, tooth extraction was decided on owing to the enlargement of the cyst, old root canal fillings and a fractured tooth. When cysts are large, they tend to expand the surrounding bone. In many cysts, there is a tendency for the epithelium to separate from the underlying cyst wall.⁷ Histopathologically, they typically show a thin, friable wall, which is often difficult to enucleate from the bone in one piece, and have small satellite cysts within the fibrous wall. In this case, the cyst was enucleated from the bone in one piece.

Cysts tend to recur after treatment.⁸ The goals of treatment should include the elimination of the potential for recurrence while also minimising the surgical morbidity. There is no consensus on adequate and appropriate treatment for this lesion. Recurrence can occur for several reasons. The first is incomplete removal of the original cyst's lining. The second is the growth of new cysts from small satellite cysts of odontogenic epithelial rests left behind after the surgical treatment. The third is the development of an unrelated cyst in an adjacent region of the jaws, and this is misinterpreted as a recurrence. It is believed that the two most common reasons for recurrence are incomplete cyst removal and new primary cyst formation.⁹ The majority of recurrence cases occur within the first five years after the treatment. Many attempts have been made to reduce the high recurrence rate by improved surgical techniques. The aim of using the Er:YAG laser in this study was to achieve cleansing of the extraction sockets and cystic cavity, as well as smear layer removal, during the cyst enucleation for healing and no recurrence. It is important to remember that microbes initially cause the lesion and continue to maintain the immune response and, thus, the apical periodontitis. The time that is required for healing in these cases ranges from eight to 14 months. Follow-up on the process of healing should be done every six months for a duration of at least four years.

In this specific case, it had been decided on the use of a PIPS tip and a modified PIPS protocol for enhanced removal of residual cystic tissue and the smear layer from the surrounding bone. The PIPS protocol has previously been used for enhanced root canal therapy.⁶ Cleaning and disinfection of the root canal system are some of the most important goals in endodontic therapy. Conventional endodontic treatment is not fully effective owing to microbial colonisation of dentine of the root canal walls in premolars and molars.^{10–13} The PIPS technique uses low energy levels and short microsecond pulse rates (50µs) to generate high peak power. Each pulse interacts with the water molecules, creating successive shock waves that lead to the formation of a powerful streaming fluid and facilitate 3D movement of the irrigation solution.⁶ Using the Er:YAG laser with sub-ablative parameters (average power of 0.3W and 20mJ at 15Hz) has proven to be an effective irrigant agitation technique and an



Figs. 7a & b: The CBCT scan of teeth #15 (a) and 16 (b) after three months revealed natural hard-tissue healing. **Figs. 8a & b:** The CBCT scan at the nine-month follow-up revealed that hard-tissue healing was complete.

effective technique for removing the smear layer in endodontic treatment.^{6,14} When the laser was activated in a limited volume of fluid, the high absorption of the Er:YAG wavelength in water and the short pulse duration (50µs) that was used resulted in a photoacoustic phenomenon in the extraction sockets. The resulting cavitation was expected to effectively remove the smear layer and residual tissue tags and potentially decrease the bacterial load within the bone tubules, as previously observed in hard tissue. In this case, by using lower sub-ablative energy, combined with a short pulse duration, and restricting the placement of the fibre tip to within the coronal portion of the extraction sockets, undesired thermal effects on the tissue were also avoided.⁶

Conclusion

This case report presents successful surgical management and healing of a large cyst with an Er:YAG laser

using a modified PIPS protocol. Easy-to-select operating modes and an advanced laser beam delivery system enhanced the precision and performance of the laser treatment for optimal clinical efficacy.

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