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CASE REPORT

Recovery of Pulp Sensibility After the Surgical Management of a Large Radicular Cyst: A Case Report with a 4.5-Year Follow-up

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ABSTRACT

In addition to pathogenic teeth associated with cysts, the roots of adjacent teeth are often included in the cystic cavity. Whether these teeth require elective endodontic treatment followed by cystic enucleation remains unclear. In the case presented herein, we aimed to preserve the pulp of the teeth included in the cystic lesion. Unfortunately, the sensibility of the included teeth was negative after endodontic surgery, including cystic enucleation. However, the sensibility recovered after 1 year and was maintained throughout a 4.5-year follow-up. Therefore, we suggest that elective endodontic treatment of the included teeth should be avoided, and further research should be conducted regarding this issue.

Keywords: Cyst, elective, endodontic, pulp, sensibility, surgery

HIGHLIGHTS

- There are currently no treatment guidelines for the teeth included in a cystic lesion.
- A lack of response to pulp sensibility testing should not be considered a conclusive indicator of pulp necrosis in included teeth.
- Instruction-adherent patients are eligible for the preservation of pulp without elective endodontic treatment.

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INTRODUCTION

Bacterial contamination of pulp tissue results in the development of periapical lesions, such as periapical granulomas, periapical abscesses, or radicular cysts. Radicular cysts, a subtype of inflammatory cysts, are among the most common odontogenic cysts (1). Following pulpal necrosis or insufficient root canal treatment, the inflammatory process may cause a large periapical lesion, such as a radicular cyst (2, 3). According to previous reports, the prevalence of radicular cysts within periapical lesions varies between 15-55% (4, 5). The current literature proposes different therapies to treat radicular cysts, such as conservative root canal treatment without adjunctive therapy, decompression, aspiration through the root canal, marsupialisation, apical resection, and surgical enucleation (6, 7). Among these treatments, surgical enucleation of radicular cysts has been the most effective and reliable method to treat the cysts (8).

In addition to the pathogenic tooth, adjacent teeth are often located in the cystic capsule; these healthy vital neighbouring teeth are referred to as "included teeth" or "involved teeth" (9). When performing cyst enucleation, clinicians have long considered devitalisation of the included teeth to be inevitable (10). Therefore, the rationale for prophylactic treatment is to prevent future apical periodontitis. Notably, elective (so-called intentional) endodontic

treatment is often considered to prevent infections (11). In one recently reported case, the root canals of included teeth were treated before cyst enucleation, even though the teeth responded to the cold test (12). However, the histologic findings confirmed that the extirpated pulps were vital. The authors stated that the included teeth needed to be treated endodontically because they would be inevitably devitalised during the enucleation procedure (12). However, unlike elective root canal treatment before surgery, monitoring the sensibility of the included teeth may be considered to support their preservation. Preserving or regaining tooth sensibility in the perioperative period is important to maintain possible proprioceptive defence mechanisms of the pulp, which provides an alarm system against any tissue injury and protects the pulp from further damage and tooth fracture (13). However, the vulnerability of a tooth without vital pulp to external irritation or damage should also be considered during the monitoring period. To date, there is no consensus regarding this decision. In the case presented herein, we preserved the pulp of the included teeth and confirmed the recovery of vitality with complete healing of the cystic lesion. This case also highlights evidence of the recovery of pulp sensibility and supports the choice to preserve the pulp of included teeth without elective endodontic treatment.

CASE PRESENTATION

Dental History and Diagnosis

A 42-year-old woman presented with a non-contributory medical history and a chief complaint of gingival soreness in the mandibular anterior region. The left mandibular canine (#33) was treated endodontically approximately 2 years previously. A radiographic examination revealed a large periradicular lesion in the anterior region (Fig. 1a-c). The teeth with radiolucent lesions (#31, 32, 33, and 41) had a normal response to palpation, percussion, and bite tests.

Then, the teeth were isolated with cotton rolls to verify pulpal status using an electric pulp test and cold test. For the electric pulp test, toothpaste was applied to the incisal edge and the cervical tooth surface. A probe tip of the electric pulp tester (Gentle-Pulse Pulp Vitality Tester D624MS, Parkell Inc., Edgewood, NY, USA) was then applied to the site. For the cold test, the examiner sprayed a cotton pellet with refrigerant spray (Endo-Ice Green, Coltene/Whaledent, Cuyahoga Falls, OH, USA) until it was soaked, and the pellet was then placed onto the crown of the tooth at the middle third of the labial surface for 10 seconds or until the patient raised a hand to indicate a cold sensation. When the patient showed a response to electric and cold stimuli, it was recorded as sensible (positive). When the patient showed no response to the stimulus, it was recorded as non-sensible (negative). The right mandibular premolars were used as controls. Each tooth was tested twice to ensure consistency.

The pulps of the lower incisors associated with the lesion (#31, 32, and 41) responded normally to the cold and electric pulp tests. Therefore, the included teeth were considered sensible. Based on the clinical and radiographic findings, the pulpal and periapical diagnosis were made: previously treated, symptomatic apical periodontitis on #33. Considering the aforementioned findings, endodontic surgery was planned after obtaining informed consent from the patient.

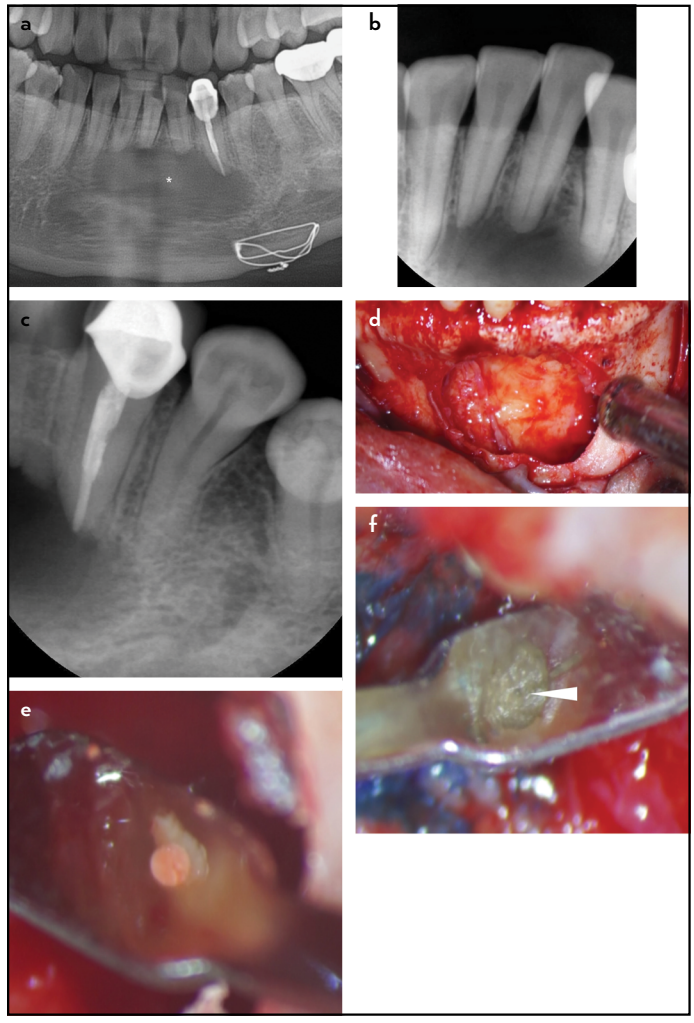

Figure 1. Diagnostic radiographs and clinical features of the surgical procedure. (a) Preoperative panoramic and (b, c) periapical radiographs showing a large periradicular lesion (asterisk). (d) Bony cavity after cyst enucleation. (e) The resected root surface. (f) The root-end cavity filled with mineral trioxide aggregate

Surgical Procedure and Follow-up Visits

After infiltration with local anaesthesia, a full mucoperiosteal flap was reflected, and the cystic tissue was enucleated (Fig. 1d). Consequently, the root apices of #31, 32, and 41 were exposed. The root end was resected and examined under a microscope (Global Surgical Co., St. Louis, MO, USA) (Fig. 1e). Next, a retrograde cavity was prepared using an ultrasonic tip (KiS tip, Young Specialties, Algonquin, IL, USA) connected to an ultrasonic device (P-5 Newtron XS; Satelec, Mount Laurel, NJ, USA), which was set on "8", the setting suggested as suitable for endodontics by the manufacturer. According to the manufacturer's information, the vibration frequency of the ultrasonic device ranges from 28 to 36 kHz. Then, the prepared root-end cavity was filled with a mineral trioxide aggregate (Endocem MTA; Maruchi, Wonju, Korea) (Fig. 1f, Fig. 2a, b). After confirming blood filling in the bony cavity, the flap was repositioned and sutured with 5-0 monofilament nylon (Ethilon;

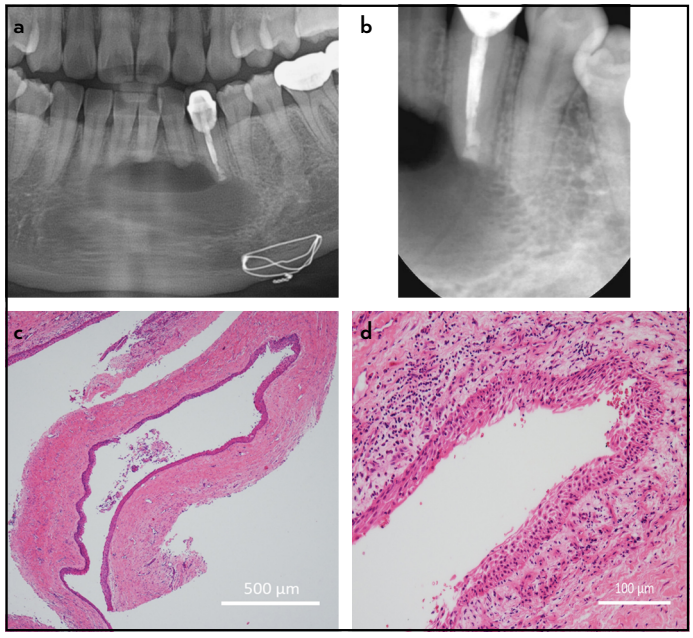

Figure 2. Postoperative radiographic and histologic features. (a) Panoramic and (b) periapical radiographs after surgery. (c) Fibrous connective tissue lined by stratified squamous epithelium (40×). (d) Infiltration of chronic inflammatory cells (200×)

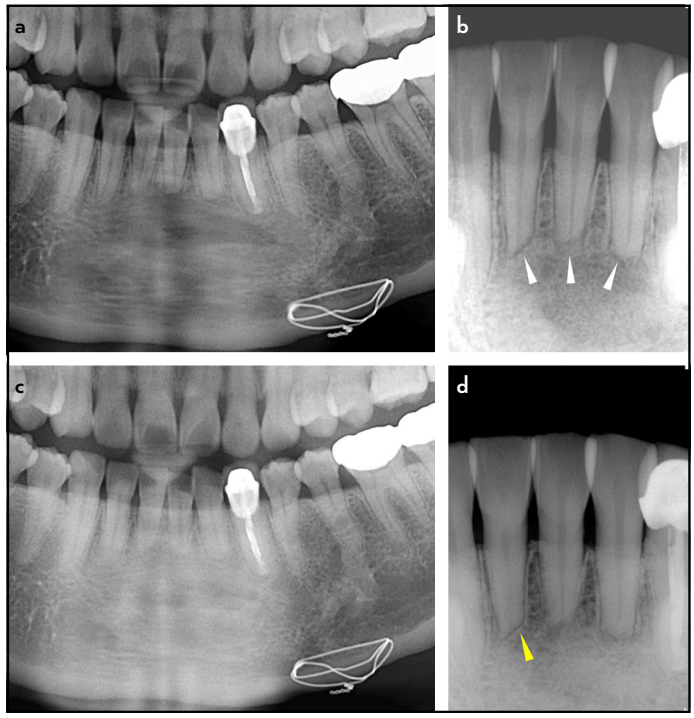

Figure 3. Radiographic features on follow-up examinations. (a) 1-year follow-up panoramic and (b) periapical radiographs. Note the resorbed apical portion of the roots (white triangles). (c) 4.5-year follow-up panoramic and (d) periapical radiographs. Complete bony healing was verified, and the root resorption did not progress further. The periodontal ligament space was seen as a narrow radiolucency between the root and the lamina dura (yellow triangle)

Ethicon, Somerville, NJ, USA). The excised tissue was sent to an oral pathologist and diagnosed as a radicular cyst with stratified squamous epithelium (Fig. 2c) and infiltration of chronic inflammatory cells (Fig. 2d). Pulp sensibility of all the included incisors was absent after 1 week.

After 6 months, an electric pulp test and cold test were performed on the included teeth (#31, 32, and 41), and the results were positive on #31 and 32 but not on #41. Finally, the pulp of #41 was found to be sensible on a 1-year follow-up visit (Fig. 3a). Therefore, the pulp sensibility of all the included teeth recovered. Furthermore, root resorption limited to the apex of the teeth was also observed (Fig. 3b). At a 4.5-year follow-up, complete bony healing was found, and all included teeth showed no problems regarding function and tooth discolouration. All included teeth (#31, 32, and 41) responded normally to sensibility tests, including the electric pulp and cold tests. Pulp sensibility was maintained (Fig. 3c), and root resorption did not progress (Fig. 3d).

DISCUSSION

Many clinicians choose to devitalise included teeth because of the risk of possible trauma or inflammatory reaction when performing the enucleation of radicular cysts (14, 15). Moreover, a negative response to sensibility tests before or after cyst enucleation surgery generally indicates pulp necrosis (16). However, efforts should be made to avoid unnecessary devitalisation whenever possible because of the pivotal role of vital pulp in defence and repair mechanisms and their inherent value as a source of stem cells. In this case, the pulp sensibility of the included teeth recovered even though the vessels and nerves were presumably completely amputated during the cyst enucleation procedure. Nevertheless, nerve regeneration is thought to have occurred, and this recovery may be attributed to several mechanisms. First, we verified blood filling in the bony cavity before flap repositioning, which might have affected recovery. A previous review claimed that blood clots formed in the bone cavity after cyst enucleation could potentially promote revascularisation (17). The authors stated that the blood clot seems to be a natural biological filling of the residual cavities, when it is able to conserve the residual bone walls provided by the periosteum and endosteum (18). In addition to the role of the blood clot as a natural cavity filling, it also contributes to nerve regeneration. First, the blood clot is a rich source of various growth factors involved in neurogenesis and angiogenesis (18). Secondly, one of the hypothesised mechanisms attributes reinnervation to the survival of dental pulp stem cells (DPSCs) from residual vital apical pulp tissue. Even in mature teeth, some vital pulp tissue might remain despite the presence of a periradicular lesion (19). In addition, DPSCs have the potential to differentiate into neuronal cells *in vitro* and can induce axon guidance (20). Thirdly, another possible mechanism is that the pulp canal receives collateral reinnervation by the sprouting or ingrowth of neighbouring ipsilateral nerves, similar to reinnervation in reimplanted or autotransplanted teeth after surgery or involved teeth after mandibular fractures (21, 22).

The situation in the present case is similar to that of autotransplanted teeth in terms of vessel and nerve amputation. Traditionally, the pulp of mature teeth is not expected to survive after autotransplantation. However, in some cases, revascular-

isation has been observed after autotransplantation (23, 24). Presumably, the likelihood of pulpal infection or damage to the included teeth in cystic lesions may be lower than that in replanted teeth. In addition, all the included teeth, in this case, were single-rooted, and the wide apical foramina might have facilitated revascularisation. Indeed, in extracted transplants, adverse findings were found more frequently in molars than in premolars or canines (24).

In this case, we did not perform any regenerative approach using a bone graft or membrane after cyst enucleation, although these are frequently used in various surgical procedures. According to the review article by Lin et al. (25), biologically, a blood clot is a better space filler than bone grafting materials since it contains the own biologic products of the host to provide an excellent scaffold. They also concluded that no definitive evidence demonstrates that the application of membrane barriers in large bony lesions has a better long-term outcome than a control group in periapical surgery (25). Meanwhile, a key factor for bony repair is the periosteum because it may act both as a source of osteocompetent cells and as a barrier against the infiltration of epithelial cells into the healing site (26). Similarly, according to a more recent literature review of cyst enucleation, the available data did not indicate the superiority of additional bone grafts (4). Furthermore, a radiopaque bone filler or bone substitute may confound the radiographic interpretation of periapical healing. Even though the usefulness of bone grafts for revascularisation of the included teeth remains incompletely investigated, the present case supports the opinion that careful enucleation of a large radicular cyst without bone grafting may be performed without complications.

The lesion size and type should be considered when deciding whether to use a regenerative approach using a membrane barrier in endodontic surgery. The best application of membrane barriers in endodontic surgery appears to be in combined endodontic-periodontal lesions or large periapical lesions communicating with the alveolar crest. As a typical example, guided tissue regeneration techniques may improve the outcome of bone regeneration after surgical endodontic treatments of teeth with "through-and-through" lesions because these techniques aim to improve the self-regenerative process by blocking the undesired proliferation of gingival connective tissue or the migration of oral epithelium into the defect (27). However, unlike these lesions, the present case involved a large cyst originating from a primary endodontic lesion without any periodontal involvement. Therefore, an additional regenerative approach was not deemed necessary.

The root dentine is not usually resorbed because it is protected by the periodontal ligament and precementum (28). On the contrary, osteoclasts may mechanically stimulate the denuded root dentine when the protective barriers are damaged and elicit resorption (29). In this case, the periodontal ligament and precementum of the exposed root apex might have been scraped off and damaged by the enucleation procedure. Consequently, periapical root resorption occurred in the included teeth (Fig. 3b). However, the resorption was transient and sustained until the periodontal ligament was regenerated, which is seen as a narrow radiolucency between the root and lamina dura (Fig. 3d). In addition, tooth #41 showed partial pulp obliteration with no apparent crown discolouration. Presumably, the included teeth inevitably underwent trauma during surgical enucleation of the cyst. Calcific metamorphosis consists of the pulp response to trauma, characterised by the rapid deposition of hard tissue within the root canal and pulp chamber space. However, the exact pathophysiological mechanism underlying pulp canal obliteration remains unknown.

CONCLUSION

Attempting to preserve the pulp sensibility of the included teeth is worthwhile because doing so preserves the physiological and anatomical functions of the teeth. However, the results from the sensibility test on the included teeth should be interpreted with caution. Instruction-adherent patients are eligible for this option because strict periodic follow-up is required to monitor the status of the teeth to prevent complications.

Disclosures

Informed consent: Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

Conflict of interest: The authors deny any conflict of interest.

Peer-review: Externally peer-reviewed.

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