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Case Report

Periradicular regenerative surgery guided with 3D CBCT reconstruction: report of a case

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Abstract: Preciseness, minimally invasiveness and digitization are the objectives of periradicular surgery. This case presents two maxillary incisors involved in a large periradicular cyst, which was in proximity with naso-palatine nerve canal. We innovatively applied cone-beam CT (CBCT) three-dimensional (3D) reconstruction technique to evaluate the cyst location, root involvement condition, as well as the risky area of damaging naso-palatine nerve. Based on the analysis in 3D reconstruction, we performed cyst enucleation, apicoectomy, as well as root-end filling. In order to maintain the thickness and shape of the alveolar bone, this case applied regenerative technique as well. At 3 months follow-up, the patient showed an uneventfully healing in the surgical area, and the radiographic examinations revealed the bone formation in the apical area. This case report demonstrates that CBCT 3D reconstruction has the value of pre-operative evaluation, and regenerative technique could achieve a successful outcome in periradicular surgery.

Keywords: Periradicular surgery, CBCT reconstruction, regenerative technique, apicoetomy, root-end filling

Introduction

In order to treat tooth with unresolved periapical lesions, especially when the size of the lesion is relatively large and prognosis of non-surgical root canal therapy (RCT) is uncertain, it is recommended to apply endodontic microsurgery-periapical surgery [1]. For a tooth with large periapical cyst, the routine procedures include root canal therapy, cyst enucleation, precise apicoectomy, and root-end filling [1, 2].

However, without detailed pre-operative analysis, periapical surgery could lead to extensive bone damage, unclear surgical exposure and high risks of complications. Therefore, we advocate the use of cone-beam CT (CBCT) reconstruction, which could visually present the cyst, bone, tooth, and other major anatomic structures such as nerves [3, 4].

Here, we present a case to describe the innovate use of CBCT three-dimensional (3D) reconstruction. The challenge of this case is that the cyst locates in proximity to nasopalatine nerve. Surgery based 3D reconstruction analysis could avoid the complication of nerve damage. To maintain the alveolar bone shape, regeneration technique is applied as well.

Report

Clinical and radiographic presentations

A 33-year-old man was referred to the Department of Endodontology, Shanghai Stomatolgical Hospital, Fudan University, Shanghai, in May 2017 with the chief complaint of constant swelling in the apical area of the tooth #21 and #22. He had a history of trauma 20 years ago, and since then painless swelling had been developed. Root canal therapy was performed in both tooth #21 and #22 three months before the referral, but the swelling persisted.

At presentation, there was labial gingival swelling and tenderness to palpation associated with tooth #21 and #22 (especially #21). No fistula or deep probing pocket depth was presented. X-ray examination revealed the dense filling roots, in addition to an 8 mm×9 mm periapical radiolucency involving roots of #21 and #22 (**Figure 1A**). Tooth #21 was over-filling. CBCT examinations showed the lesion was

Figure 1. X-ray presentations of the tooth before and after surgery. A. A lesion (1.6 mm*2.9 mm) exists with the involvement of tooth #21 and #22 before surgery; B. X-ray shows the lesion is filled with normal bone at 3 months follow-up after the surgery.

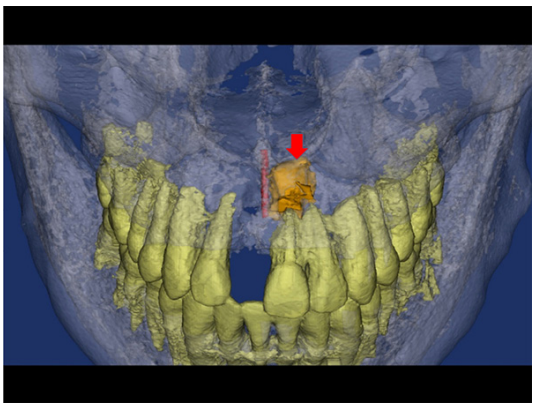

Figure 2. CBCT 3D reconstruction of the case. In the view of the 3D reconstruction of CT by mimics software, teeth, bone, lesion as well as the nasopalatine nerve canal are segmented out with different colors.

about 8 mm×9 mm×10 mm with the buccal and palatal bone defect, and roots of 21 and 22 were inside the lesion. Nasopalatine nerve canal was in proximity to the lesion.

This study followed the Declaration of Helsinki on medical protocol and ethics and the regional Ethical Review Board of Shanghai Stomatological Hospital, Fudan University approved the study. The patient was informed about surgical purpose, surgical protocol, recovery period, possible complications and signed a consent form.

CBCT 3D reconstruction

The data of the CBCT scan (slice thickness was 0.25 mm; GE, USA) were imported to Mimics 19.0 software (Materialize Co, Leuven, Belgium) for 3D reconstruction. Teeth, bone, lesion and the nasopalatine nerve canal were segmented out (**Figure 2**).

The detailed information showed in CBCT 3D reconstruction are listed as follows: ① the length of root is 21.07 mm (#21) and 20.54 mm (#22); ② about 2 mm of roots of tooth #21 and #22 were involved in the lesion; ③ the posterior and inferior area of the lesion's inner side was in shortest distance (about 1 mm) to the nasopalatine nerve canal.

Surgical procedure and follow up

The surgery was performed by Dr Zhu Jing, who is chief of endodontics with more than 20 years clinic experience. Under local anesthesia (primacaine with adrenaline 1/100000, 2.5 mL), a full thickness sulcular flap was elevated, with one release incision distal to the left canine. To achieve a better surgical exposure, a round bur with diameter of 1.6 mm was applied to widen the buccal bone defect to about 5 mm×5 mm. The cyst-like lesion was then enucleated carefully (especially the posterior, inferior area of the inner side) and sent to the pathology department. The apicoectomy was achieved using surgical fissure bur, and the root-end cavity was filled with mineral trioxide aggregate (MTA, ProRoot MTA, Dentsply Tulsa Dental, USA) (**Figure 3A**, **3B**). Then, the xenograft (Bio-Oss) and collagen membrane (Bio-Gide) were used to fill the defect (**Figure 3C**, **3D**). The flap was repositioned and sutured.

The patient was reviewed 7 days after the surgery. There had been minimal pain and localized swelling. Histopathology result confirmed the presence of a radicular cyst. Then the patient was reviewed 1 month and 3 months after surgery. The clinic examination showed healing progressed uneventfully, and the radiographic examinations revealed the bone forma-

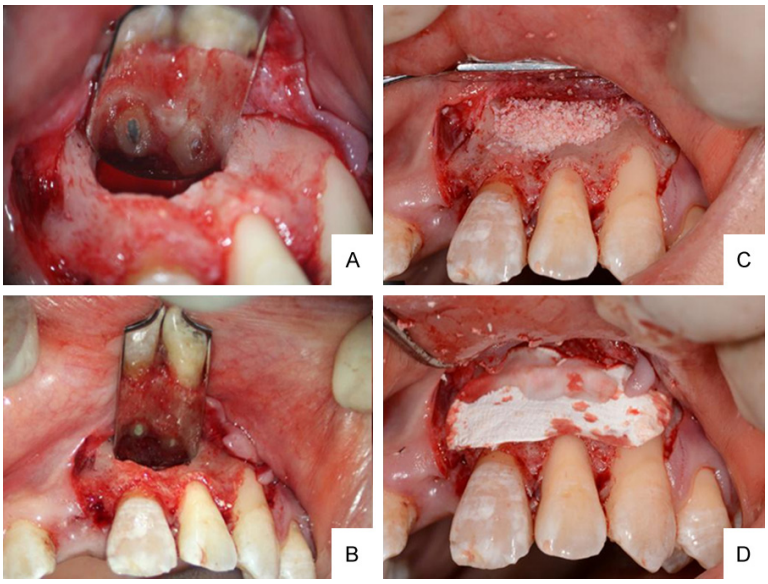

Figure 3. The surgical procedure. A. Apicoectomy; B. Root-end filling; C. The defect is filled with Bio-Oss; D. The surgical field is covered with Bio-Guide.

tion and remodeling in the apical area (**Figure 1B**).

Discussion

There are two features of the periradicular lesion in this case: (1) the lesion is in proximity with the important structure-naso palatine nerve canal; (2) the lesion has caused large bone defect. Therefore, it is necessary to prepare a careful pre-operative analysis, and regeneration technique is valid. In this case, we innovatively applied CBCT reconstruction in three dimensions, which improve the peri-operative evaluation. Besides, we performed regeneration surgery after cyst enucleation to accelerate bone remodeling.

It is common to discover a periapical lesion with apical X-ray image [1, 5]. However, X-ray has the shortcomings of overlapping and its bidimensional character. Therefore, CBCT is advised as a supplemental tool, for its advantages of showing the lesion's space location as well as its relationship with other anatomic structures [5]. Preciseness, minimally invasiveness and digitization are the objectives of modern surgery. CBCT reconstruction is the development trend in the endodontic surgery. The CBCT 3D reconstruction could segment bone, teeth, nerve and the lesion, thus it could visually provide the location information to avoid the risk of complications. Besides, the digital simulation based on the reconstruction could help the case with intact bone to design the surgical approach. In this case, we use the X-ray image to discover the lesion, then applied CBCT for size and location evaluation, and finally we performed 3D reconstruction to detect the risky area and provide an overall surgical guidance.

Periradicular cyst with large bone defect could be treated with two methods: ① decompression [6-8]; ② regeneration technique [9]. Decompression is a conservative treatment for odontogenic cyst with high successful rate in literature [6, 7]. By creating an opening to the cyst, decompression could reduce pressure of the cavity to induce bone formation. Then, the method provides good surgical access to smaller lesions, which not only generate few postoperative complications, but also produce great therapeutic effects with less recurrence [6, 7]. In the previous study, it is suggested that the reaction of decompression varies depending on the cyst [7, 10]. The reduction rate in keratocystic odontogenic tumors (KOT) was higher than the other cyst like dentigerous cysts and radicular cysts. It may due to the aggressive character and greater size of KOT. Therefore, in this case of periradicular cyst, it is not advised to use decompression. The other reason of not applying decompression in this case is the long treatment procedure.

In this case, careful enucleation is a time-saving and effective method. After enucleation, apicoectomy is performed to resect the infected tissue in 2~3 mm root-end [11, 12]. MTA, a reliable bioactive material, is then used as a root-end filling material to resolve the apical periodontitis [13, 14]. After enucleation, apicoectomy and root-end filling, there is a big space left in this case. Thus, how to deal with the large cavity became another problem.

What is the healing prognosis after enucleation? In literature, the following characteristics

were significantly associated with higher healed rates in periradicular surgery [15, 16]: cases without preoperative pain or signs, cases with good density of root canal filling, and cases with absence or size < or = 5 mm of periapical lesion. In this case, the patient has no preoperative pain, and the density of root canal filling is adequate, but the size of the lesion is > 5 mm. In histological study, periapical wound healing requires recruitment and differentiation of progenitor cells/stem cells into osteoblasts, cementoblasts, and periodontal ligament cells in large periapical lesions [17-19]. It is proposed that if the size of the osseous defect is too large, osseous regeneration of the wound will not occur and the defect will heal by fibrous connective tissue repair. In some clinic research, guided tissue regeneration (GTR) is found beneficial for the treatment of large periapical lesion [18]. Bio-guide could be used as a barrier to treat "through-and-through" lesions by blocking undesired proliferation of gingival connective tissue or migration of oral epithelium into the defect [19]. Bio-Oss is a bovine bone, it could be used to fill the cavity and improve the bone regeneration [20]. Therefore, in this case, both bio-guide and bio-oss are applied in order to conserve the thickness and shape of the alveolar bone, as well as to improve the bone regeneration.

To our knowledge, it is the first to report 3D CBCT reconstruction for pre-operative evaluation in periradicular surgery. In this case, we applied regeneration technique in endodontic surgery, which is not widely reported as well. There are some improvements of the research on this topic in the future. Firstly, CBCT 3D reconstruction and surgical simulation will be more valuable to locate the lesion with intact bone. Secondly, piezosurgery could be applied to develop the surgical approach [21], and ultrasonic surgical tools could be used for apicoectomy, which are less invasive. Thirdly, long-term follow-up of this case should be recorded, and randomized clinical research could be designed.

Conclusion

CBCT reconstruction could be applied in the radicular surgery with value of better pre-operative analysis. For large defect after cyst enucleation, Periradicular regenerative surgery could achieve a successful clinical and radiographic outcome.

Disclosure of conflict of interest

None.

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