

# Preservation the Pulp Activity of the Involved Teeth in Jaw Cyst: an Observational Study

**Gang Niu**

Fujian Medical University School and Hospital of Stomatology

**Qing-ling Li**

Fujian Medical University School and Hospital of Stomatology

**Yong-gang Tang**

People's Hospital of Changji Hui Autonomous Prefecture

**Jing-jing Lv**

People's Hospital of Changji Hui Autonomous Prefecture

**Li-song Lin**

Fujian Medical University School and Hospital of Stomatology

**You-guang Lu** (✉ [fjlyg63@fjmu.edu.cn](mailto:fjlyg63@fjmu.edu.cn))

Fujian Medical University School and Hospital of Stomatology

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## Research Article

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# Abstract

**Background:** Jaw cyst is the most common disease of the oral and maxillofacial region. In addition to the pathogenic tooth, the roots of some teeth are often located in the cavity of the cystic capsule. Whether these involved teeth require root canal therapy and apicoectomy is still inconclusive. In the present study, we aimed to preserve the pulp activity of involved teeth in jaw cyst by improved operation.

**Methods:** In our improved surgical method, the root canal therapy was not performed on the involved teeth, and no apical excision was performed during the operation. 63 involved teeth in 20 cases of jaw cyst treated by our department were selected between September 2015 and October 2017. The involved teeth were diagnosed by X-ray, CBCT, and a pulp vitality test before surgery. We observed the pulps' activity in the involved teeth and the efficacy of surgery for 12-36 months.

**Results:** Electrical activity test of 63 involved teeth pulp in 20 patients with jaw cyst was normal or insensitively before operation. The involved teeth were preserved by improved surgical method. After 12-36 months' follow-up, the pulp activity of 53 involved teeth (84.1%) were preserved, whereas 10 teeth (15.9%) showed adverse symptoms such as redness and swelling in the apical area, fistula, and pain. These symptoms resolved after postoperative root canal therapy. Chewing function was restored well. There was no recurrence and the bone cavity gradually reduced and finally disappeared, and bone density returned to normal after long term follow-up.

**Conclusion:** Our results showed that to preserve the activity of the involved teeth for the treatment of jaw cyst by performing an improved operation method was effective.

## Introduction

Jaw cyst is the most common disease of the oral and maxillofacial region, which mainly includes odontogenic cyst<sup>[1]</sup>, non-odontogenic cyst and vascular extravasation cyst<sup>[2]</sup>. The odontogenic cysts are characterized as a maxillofacial bone destructive lesion develop from the odontogenic epithelium. It was divided into 2 main groups: inflammatory including radicular cysts and developmental including dentigerous and keratocysts. Surgery remains the major therapeutic method for jaw cyst<sup>[3]</sup>. The involved teeth are generally retained as much as possible, and if the surrounding alveolar bone has been completely absorbed, extraction is performed. The conventional surgical methods for jaw cyst, at present, are cyst curettage and apicoectomy of the involved teeth<sup>[4, 5]</sup>. At present as long as the apical area is exposed in the cystic cavity by preoperative X-ray, regardless of the pulp vitality, root canal therapy is performed before surgery, and the cystic tissues as well as intracavitary apical tissue should be removed during the operation<sup>[4, 5]</sup>. Root canal therapy and apicoectomy, as a treatment method for odontogenic cyst, have been widely accepted<sup>[4, 5]</sup>. Many scholars have found necrosis of the dental pulp and decreased pulp vitality in or surrounding jaw cyst due to inflammatory factors<sup>[6]</sup> and compression of cystic exudation in the process of cyst formation. In addition, a pathogenic tooth with its apex located in

the cyst cavity may have chronic pulpitis. If the pathogenic tooth root canal therapy and apicoectomy are not performed, it may lead to abnormal healing or postoperative cyst recurrence [7].

But there are some scholars [8] found that the recurrence of the cyst has nothing to do with the involved tooth and with the wide application of fenestration decompression in the treatment of jaw giant cystic lesions, we found that the pulp of many involved teeth, which normally require root canal therapy and apicoectomy, was effectively preserved [9,10]. If these teeth can be retained, it will effectively preserve oral function; if the pulp activity of these teeth can be preserved reasonably, the service life of these teeth will be greatly improved [11].

A pathogenic tooth with an odontogenic cyst often changes color, the apical foramen is enlarged or is absorbed, and the pulp vitality test will show no response in clinical practice. Therefore, root canal therapy and apicoectomy of pathogenic tooth should not be controversial at present. In addition to the pathogenic tooth, the roots of some teeth are often located in the cavity of the cystic capsule. Although the crown color might be normal, X-ray shows no absorption of the apex, and a pulp vitality test will demonstrate normal or insensitive. This tooth is called the involved tooth. Moreover, these phenomena also extensively exist with a non-odontogenic cyst, when the tooth is not directly related to the lesion, but the root is only surrounded or oppressed during the cyst expansion process, and there is no inflammation in these teeth [12,13]. Yet, whether these involved teeth require root canal therapy and apicoectomy is still inconclusive.

To preserve the pulp activity and anatomical integrity of the involved teeth, in this study, only the pathogenic teeth root canal was treated before surgery, and a window was opened above the root tip to remove bone during the operation, so as to preserve the involved teeth root tip and dental pulp in the jaw cyst, and "jaw cyst curettage + root tip resection of the pathogenic teeth" was performed to observe the pulp activity of involved teeth and the postoperative recovery of the jaw cyst.

## Methods

### 2.1 Clinical samples

20 patients treated in our department were selected between September 2015 and October 2017, including 13 males and 7 females. The age of the included patients with jaw cyst in our study ranged from 21 to 51 years. In total, 63 involved teeth from 20 patients were included in this study. Inclusion criteria consisted of:

- a. A jaw cyst involved at least two teeth (Fig. 1).
- b. Clinical examinations such as a preoperative clinical exam, dental radiograph, or cone beam computed tomography (CBCT) identified the pathogenic teeth and involved teeth.
- c. The pathogenic teeth had completed root canal filling before surgery.

- d. The involved teeth did not have an enlarged apical foramen, showed no root resorption on X-ray film or CBCT, and reacted normally or insensitively in a pulp vitality test.
- e. Written informed consent was obtained from each patient. If a patient had any postoperative discomfort, root canal therapy would be given.
- f. During the operation, the roots of the involved teeth were reconfirmed to have exposed roots in the cystic cavity.

## 2.2 Treatment progress

First, the involved teeth should be diagnosed by X-ray (Fig. 2–3), CBCT, and a pulp vitality test (Neosono Co-Pilot Pulp Vitality Tester) before surgery. After considering pathological scope and location, jaw cyst resection should be conducted under local or general anesthesia (Fig. 4). Next, a routine trapezoidal or angular incision should be performed on the labial mucosa to expose the labial lesions. If the lateral labial bone plate is absent, a complete removal of cyst should be done. Second, the cystic lesion area should be stripped to keep it away from the teeth. It must be removed carefully under direct vision around the area of the involved teeth. Performing a complete removal of the fiber lining is not suggested, so as not to pose an impact on the blood supply and nerve fibers of the involved teeth.

Finally, the treatment of the pathogenic teeth should be carried out. The root of the pathogenic teeth should be thoroughly treated around the root of the pathogenic tooth. The sac wall that is attached to the root of the pathogenic tooth cannot be easily removed could be burned and scratched with electric knife, and then the root tip can be resected for 3mm by round burs while the involved teeth are well protected. If the labial bone plate exists, chisel the apical alveolar bone 5 mm above the root tip of the involved teeth to remove any intact jaw cyst. Treatments for the root apex of both pathogenic teeth and involved teeth are as previously described. After that, we irrigated the chamber with sterile saline solution, ensuring sterile conditions and non-inflammatory factors in the cystic space. The root tip should be covered with a gelatin sponge. If the size of the cavity is less than three teeth positions, suture it after debridement. If it is larger than four teeth positions, fill the hole with iodoform gauze and then suture wound.

Patients whose preoperative diagnosis tended to be of a non-odontogenic cyst were treated the same as those with an odontogenic cyst. In this circumstance, if the root apex of the involved teeth were not exposed in the cavity, only the cyst itself would be completely removed during the operation. On the contrary, if there was only an adjacent relationship between the cyst and the involved teeth, the cyst would be stripped and the roots of the involved teeth would require no treatment.

## 2.4 Postoperative evaluation

Postoperative follow-up was conducted for 12 to 36 months. The patients underwent a pulp vitality test at one week, one month, three months, 6 months, and 12 months postoperatively and underwent X-ray radiography at three months, 6 months, and 12 months after surgery (Fig. 5). The criteria for protecting the pulp of the involved teeth successfully were as follows.

- a. The incision has healed well and there is no inflammation in the surgical area.
- b. The occlusion of the involved teeth is functioning well without any discomfort.
- c. The pulp vitality of the involved teeth has returned to normal after the operation.
- d. The scope of the lesion has gradually narrowed and the bone density has gradually increased.

If any of the following symptoms appeared within one year after surgery, preservation of the involved teeth was considered a failure.

- a. The patient experiencing toothache or any discomfort should be given root canal therapy.
- b. The mucosa of the surgical area showed redness, swelling, and pus. After root canal therapy, inflammatory reaction disappeared.
- c. There was no cystic space reduction or enlargement around the involved teeth in an X-ray.

## Results

### 3.1 Pathology diagnosis

According to the pathology diagnosis, among these 20 patients, there are 7 patients with radicular cyst, 5 with periapical granulomas, 5 with dentigerous cyst, two with odontogenic squamous intraepithelial lesion and one with nasopalatine cyst. Combined with clinical manifestations, the final diagnosis was 17 cases of odontogenic cyst and three cases of non-odontogenic cyst.

### 3.2 Pain intensity

Pain intensity was recorded in all patients on the postoperative day one. It was assessed by Visual Analogue Scale (VAS) <sup>[14]</sup>. For each patient, pain was recorded as follows: mild pain (VAS, 1–2) was 16 patients (80%), and moderate pain (VAS, 3–4) was four patients (20%), heavy pain (VAS, 5–6) was 0 patients (0%) <sup>[15]</sup>.

### 3.3 Follow-up observation

According to the 12–36 months follow-up of 63 involved teeth from 20 patients, 53 of them recovered well after surgery, and 10 teeth of the 7 patients finally failed to preserve the pulp vitality (Table 1). Within 1 week after the operation, three teeth of the two patients had gingival swelling and fistula. Within 1 month after the operation, 10 teeth of the 7 patients had gingival swelling and pain. The symptoms of the 10 involved teeth in the 7 patients were not relieved after four weeks of observation. After postoperative root canal filling, the symptoms disappeared after two weeks. The integrity of the 63 involved teeth roots were preserved well, and the pulp vitality of 53 of the involved teeth were restored and they recovered. 12 months after surgery, the area of the jaw cystic lesion had decreased significantly, and no recurrence or discomfort appeared (as shown in Fig. 5).

Table 1  
Follow-up of 63 involved teeth from 20 patients

63 involved teeth in 20 patients	Red and swollen gums*	Sensitive percussion of involved teeth#	No response to pup vitality test#	Decreased pulp vitality#	Normal pulp vitality#	Cystic space reduction*
Preoperative	6	0	0	48	15	0
After 1 week	2	3	5	45	13	0
After 1 month	7	10	10	43	12	0
After 3 months	0	0	10	32	21	9
After 6 months	0	0	10	20	33	20
After 12 months	0	0	10	17	36	20

\*Number of cases; #Number of teeth.

## Discussion

The objectives of jaw cyst resection are to terminate the pathological process, promote the restoration of jaw bone tissue, and restore the anatomical and physiological functions of the teeth in the cyst area [15, 16]. According to traditional surgical methods, root canal therapy and apical resection should be adopted as long as the tooth can be retained, regardless of the pulp activities in the cystic area [4, 5]. Although this surgical method decreased the possibility of postoperative infection in the lesion area, it also destroys the anatomical structure and pulp activity of the teeth, consequently reducing the stability and physiological function of involved teeth, despite that the pulp vitality of involved teeth generally does not have inflammation. We also found that growth of the bone around the involved teeth in the cavity is accompanied by the reconstruction of bone around the root apex and recovery of pulp activity after the fenestration [10]. Therefore, if the involved teeth apex is properly preserved and treated, the integrity of tooth and pulp activity of the involved teeth will be well protected and restored [10, 12].

In this study, to protect the root integrity and pulp activity of the involved teeth during operation, the following improvements of surgical methods were made.

- a. The involved teeth and pathogenic teeth should be diagnosed before surgery, and root canal therapy should not be performed on the involved teeth.
- b. The upper boundary of chiseling of the apical area of the alveolar bone should be 5 mm above the root tip of the involved teeth to protect the nerve and blood supply of the apex and to preserve the integrity and activity of pulp stem cells and periodontal ligament cells.

- c. Only the epithelial lining of the capsule wall and part of the fiber lining is cut under direct vision in the area around the involved teeth. The fiber lining can be partially retained to avoid posing a threat to papillary stem cells, multifunctional pulp stem cells, periodontal stem cells, and blood vessels in the root tip.
- d. During the operation, the cyst and the root tips of the pathogenic teeth are completely removed, but those of the involved teeth are not excised or cauterized. Then, irrigation of the chamber with sterile saline solution ensures sterile conditions and non-inflammatory factors in the cystic space.
- e. The root tips of the involved teeth should be covered with some blood clots, which would facilitate development of a physiological basis for the regeneration of normal tissues around the area and the restoration of blood vessels and nerves in the pulp.

In the clinical research, we found that the root and pulp vitality of the involved teeth located in a jaw cyst could be effectively preserved; meanwhile, the anatomical and physiological functions of the teeth would not be involved if the inclusion criteria and standard surgical methods are strictly followed and performed. (The root integrity of the 63 teeth and pulp vitality of the 53 teeth were well preserved.) Currently, dental pulp revascularization, that is, a process of tissue regeneration in an inactive tooth, has gained increasing recognition since Lwaya et al. <sup>[17]</sup> first put forward this technology in 2001. Dental pulp revascularization takes advantage of the endodontic blood channel in vitro, letting the dentin in the root canal of the permanent tooth continue its generation, thus leading to the closure of the apical pore and the growth of the root <sup>[19]</sup>. Neha et al. <sup>[20]</sup> deduced that if a sterile tissue matrix can be provided for the growth of new cells, viable pulp can regenerate, and dental pulp revascularization is the result of replantation or allograft of dead teeth. This result suggests that if a sterile tissue matrix is provided for the growth of new cells, these cells could grow in the root canal and help rebuild the blood supply to the pulp, gradually replacing the diseased tissue<sup>[19, 20]</sup>. Studies of dental pulp revascularization on chronic periapical periodontitis and tooth trauma in young permanent teeth are quite common, and many animal experiments and clinical studies, both domestic and overseas, have shown good results<sup>[23, 24]</sup>.

In some cases, a tooth with incomplete root formation may be able to reestablish blood supply after autotransplantation or replantation <sup>[25, 26]</sup>. Through a large number of clinical observations, we find that most of the pulp of the involved teeth is free of inflammation, and the blood flow and nerve activity of the involved pulp in jaw cyst treated by fenestration decompression can be preserved and restored. The endodontic vessels and nerves are abundant; in addition to the apical vessels, the endodontic vessels can communicate with the periodontal ligament and some accessory root canals <sup>[27]</sup>. Endodontic nerves are divided into myelinated fibers that conduct pain and some non-myelinated fibers nerves that regulate vasoconstriction and relaxation. Myelinated nerve fibers that conduct pain are also divided into A $\delta$  fibers and C fibers. The pulp vitality test does not accurately reflect endodontic blood flow and nerve condition of involved teeth. Involved teeth with jaw cyst have more complete pulp tissue structure and activity than the transplantation teeth. Therefore, the blood flow and nerves of involved teeth should be easier to be preserves and regenerated than the transplantation teeth.

Especially for pediatric patients, some factors occur: apex may not have completed the root maturation at the time of intervention; the pulp activity of their teeth is easier to regenerate; moreover, the lack of compliance may require a treatment in general anesthesia. Therefore, it is important to carefully evaluate the maintenance of teeth, because any cyst recurrence would increase the burden of care<sup>[28]</sup>. Through improvement of this surgical method and the principle of treatment of involved teeth, the involved teeth with normal or insensitive pulp can be preserved effectively. The operation effect is good, the anatomical structure and vitality of the involved teeth can be preserved well and the cyst also did not recur. This surgical method is worth being developed and popularized in clinical work because not only does it reduce the cost and time of treatment for patients, it also preserves the physiological and anatomical functions of patients' teeth. However, this paper as the initial study of the involved teeth preservation, the classification of cysts is not precise enough and the number of samples is small, therefore, the obtained data cannot accurately reflect the surgical effect and the pulp situation of vascular and nerve functions after this modified operation. Therefore, in the future work, we will increase the number of cases, respectively for odontogenic cyst and non-odontogenic cyst for long-term follow-up of the surgical effect and pulp activity of the involved teeth, in order to obtain more scientific and accurate experimental results.

Our results showed that preservation of the involved teeth pulp for the treatment of jaw cyst by this improved operation method was effective.

## List Of Abbreviation

CBCT cone beam computed tomography

## Declarations

### Ethics Approval and consent to participate

This study was approved by the Institutional Review Board of Hospital of Stomotology, Fujian Medical University, and written informed consent was obtained from each participant. The study was carried out in accordance with the guidelines for the care and use of human specimens and animals, including in the approved protocol.

### Consent for publication

Not applicable

### Availability of data and materials

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

### Competing interests

The authors declare no potential competing interests.

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## Authors' contributions

YGL and GN designed the study protocol and drafted the manuscript. NG, QLL and YGL reviewed the study protocol and drafted the manuscript. NG, YGT, JJJ, LSL were responsible for the experiments and procedures and NG, QLL, YGT, JJJ, LSL, YGL for data analysis. All authors carefully read and approved the final version of the manuscript. All authors read and approved the final manuscript.

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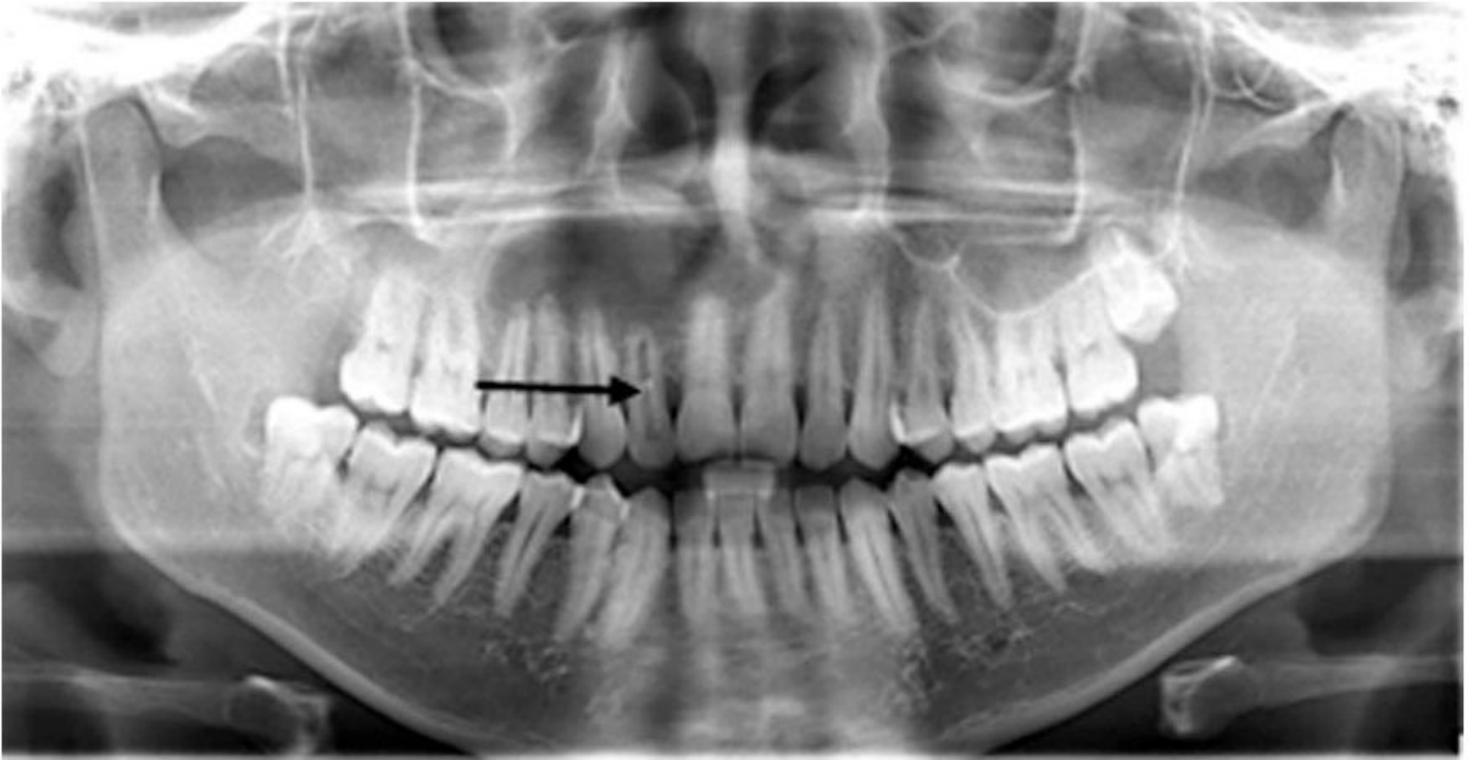
## Figures



**Figure 1**

Representative image of the intraoral view of the patients. Patient A, male, 30 years old, with a chief complaint of an abscess with pain and oozing pus in his maxillary anterior teeth for more than one year.

The arrow shows that 12 is the focal tooth, and 11, 13, 14, and 15 are the involved teeth.



**Figure 2**

Panoramic radiograph of patient A taken before surgery. The arrow shows that 12 is the focal tooth; 11, 13, 14, and 15 are the involved teeth.



**Figure 3**

Panoramic radiograph of patient B (male, 46 years old, with a chief complaint of swelling in the right maxillary for one week) taken before surgery; 11, 21, and 22 are the involved teeth, and the vitality test of these teeth was dull.



**Figure 4**

Intraoral view of patient B during the surgery; 11, 21, and 22 are the involved teeth, which have no color change.



**Figure 5**

Panoramic radiograph of patient A taken at 36 months after surgery. The cyst was healing well and the three involved teeth were preserved.