

Treatment of a patient with recurrent odontogenic keratocyst using Carnoy's solution : A case report

Hyunhee Park, Kyungrock Min, Soo Nam Yang

Department of Oral and Maxillofacial Surgery, Cheongju Hankook General Hospital, Cheongju, Korea

Odontogenic keratocyst (OKC) is a locally aggressive cystic lesion with a high recurrence rate ranging from 15% to 63%. Various conservative and adjuvant treatment modalities have been introduced to minimize recurrence. This report presents a recurrent OKC in a 17-year-old male patient managed with cyst enucleation and Carnoy's solution. The patient, previously treated for multiple OKCs, presented with a unilocular radiolucent lesion involving the distal root of #37 and cortical bone perforation. Under local anesthesia, cyst enucleation, extraction of #37, and application of Carnoy's solution for 3 minutes were performed with gauze protection of the inferior alveolar nerve. Histopathologic findings confirmed an odontogenic keratocyst. Postoperative healing was uneventful, with progressive bone regeneration observed on panoramic and CT images up to nine months. Carnoy's solution, despite restrictions due to its chloroform content, remains effective in reducing recurrence by chemically eliminating residual cystic epithelium. Long-term radiographic follow-up is recommended to monitor for potential recurrence. (THE JOURNAL OF KOREAN ACADEMY OF OSSEOINTEGRATION 2025;17(1):9-14)

Key words: Odontogenic keratocyst, Carnoy's solution, Recurrence

INTRODUCTION

Odontogenic keratocyst is a radiologically unilocular or multilocular radiolucent lesion. It has a well-differentiated sclerotic boundary and is characterized by uniform or scalloped shape¹. Odontogenic cysts are often associated with the impacted teeth, especially the mandibular third molar. Absorption of the dental root and bone expansion can be observed near the odontogenic keratocyst. Features seen in clinical and radiological findings, yellowish fluid observed upon aspiration suggest an odontogenic keratocyst, but the diagnosis is confirmed when para or orthokeratinized epithelium of 4 to 6 layers is seen pathologically².

Odontogenic keratocysts originated from the enamel organs or in the dental lamina, with rapid, aggressive growth and a high recurrent rate of 15~63%³. The treatment method affects the recurrence rate. Conservative methods include cyst enucleation, marsupialization, and adjuvant therapy includes osteotomy, cryotherapy, and Carnoy's solution⁴. Cyst enucleation and curettage showed 63% recurrence, while cyst enucleation and Carnoy's solution could reduce the recurrence rate to less than 2.5%³.

Carnoy's solution is a fixative used after enucleation, which

removes the lining epithelium, lowers the recurrence rate, and has been regularly used in treating odontogenic keratocysts². It is made by mixing 6 ml of absolute alcohol (60%), 3 ml of chloroform (30%), 1 ml of glacial acetic acid (10%), and 1 g of ferric chloride⁹.

In this case, treatment using cyst enucleation and Carnoy's solution was performed to reduce the recurrence rate of odontogenic keratocyst in consideration of the patient's age.

CASE REPORT

A 17-year-old male patient treated with enucleation in 2020, and was referred to our hospital after incidentally finding a relapse when visiting a private hospital. There were no symptoms at the first visit to the hospital on September 16, 2023. The patient's past medical history was as follows. In February 2017, cyst enucleation, extraction of #62, 63 and biopsy were done under general anesthesia. In May 2020, cyst enucleation, bone graft and biopsy of the left maxillary canine region were done. Subsequently, on September 4 of the same year, enucleation of the right maxillary region was performed. All lesions were diagnosed as odon-

Received December 15, 2024, Revised October 29, 2025, Accepted October 31, 2025

Copyright © 2025 Korean Academy of Osseointegration

Corresponding Author: Hyunhee Park, Department of Oral and Maxillofacial Surgery, Cheongju Hankook General Hospital, 106 Danjae-ro, Sangdang-gu, Cheongju 28713, Korea, Tel: +82-43-222-7000, Fax: +82-43-255-7007, E-mail: phh5443@naver.com



Figure 1. Pre-OP panoramic view (23.09.16) showed unilocular radiolucent lesion.

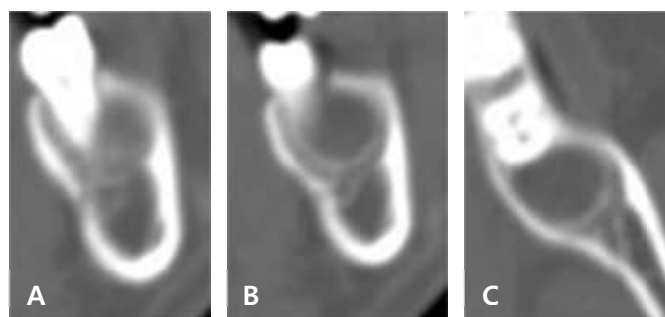


Figure 2. (A, B) Enhanced CT coronal view. (A) showed the cystic lesion contained distal root of #37 and buccal bone expansion. (B) showing cortical bone perforation and rim enhancement. (C) Enhanced CT axial view.

togenic keratocysts. 3 years later, in September 2023, at the time of visiting our hospital, a unilocular radiolucent lesion was observed in the left third molar region and included #37 distal root on the panoramic view and enhanced CT imaging (Figure 1, 2).

In our hospital, the recurrence of OKC was tentatively diagnosed by referring to the patient's past medical history, cyst enucleation, extraction of #37, and application of Carnoy's solution were planned under local anesthesia.

Under local anesthesia, vertical incision was made on the #37 mesial region and the #38 distal region. The full thickness muco-periosteal flap was elevated, extracted #37, and the cyst was exposed (Figure 3). After removing the cyst at the #38 site and extracting #37, it was confirmed that the distal wall of #37 alveolar bone was perforated (Figure 4). To prevent damage to the inferior alveolar nerve, gauze was placed underneath, and Carnoy's solution was applied for only 3 minutes (Figure 5). After washing with saline, the drain was inserted. The suture was removed after

1 week, and the post-operative condition was good and had no paresthesia.

The removed cyst was sent to the pathology department for diagnosis (Figure 6). As a result of biopsy, it was diagnosed as an odontogenic keratocyst (Figure 7). As you can see from the figure, uniformly thickened para-keratinized epithelium is lined up.

Three months after surgery, the bone of the extraction site and the cyst removed in the panoramic and CT view showed a lot of recovery (Figure 8). 9 months later panoramic and CT view also showed a more progressive healing state (Figure 9). In the meantime, the resin wire splint was placed at #26-27 buccal area to prevent extrusion of #27. The implant will be placed at #37 area after he becomes an adult. It is scheduled to be followed up in a year, and regular check-ups are required.



Figure 3. (A) After the full thickness mucoperiosteal flap was elevated, #37 was extracted. (B) Cystic lesion at #38 site was exposed.



Figure 4. Perforation of the distal part of the alveolar bone of #37 root was identified.

DISCUSSION

Many conservative and aggressive treatments have been applied to reduce high recurrence rates, but none are recognized as standard treatments. The posterior mandible area or maxillary area is a region with a high risk of recurrence. Thin cortical bone, cavernous maxilla with multiple cavities, difficulty in access to disturb complete removal of cysts, cortical bone perforation, and anatomical features such as cysts attached to overlapping mucosa

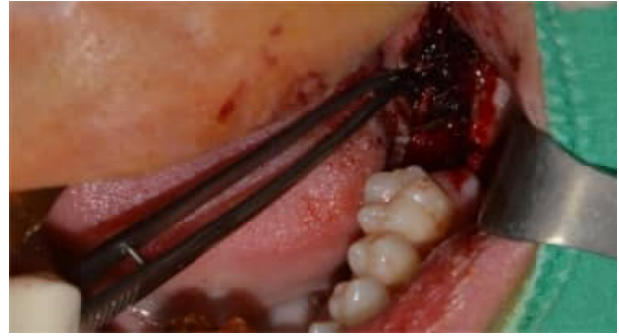


Figure 5. Gauze was placed and applied Carnoy's solution for 3 minutes.



Figure 6. The cyst was removed.

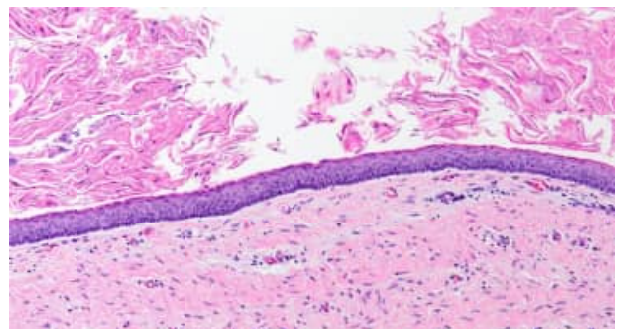


Figure 7. H&E. (×200) odontogenic keratocyst.

increase the risk of recurrence⁸. All recurrent lesions included teeth and were proximate to the inferior alveolar nerve and had cortical bone perforation⁷. Cases without cortical bone perforation showed no signs of recurrence.

If the cyst and root are adjacent together, efforts to save impor-



Figure 8. Panoramic and CT image of 3 months later after surgery.



Figure 9. Panoramic and CT image of 9 months later after surgery.

tant teeth contained in the cyst by enucleation alone during surgery will incompletely remove the cystic lesion and show a significant recurrence rate⁸. In particular, recurrence was more associated when adjacent teeth were saved in cysts combined with cortical bone perforation⁸. In this case, we tried to choose a treatment to reduce recurrence because the distal root of #37 on CT imaging was included in the lesion and cortical bone perforation was seen.

Carnoy's solution is a nucleus-fixing chemical used in histological technology and was invented by Jean-Baptiste Carnoy, a nineteenth century cytologist¹³. Carnoy's solution is used as follows. Strengthen lymph node detection during Kadeva dissection¹⁵. It is useful for tissue preparation before staining with a periodic acid-Schiff base¹⁶, an immobilizer for nuclear and mitochondrial DNA in various tissues¹⁷, and an immobilizer for preserving mucus. It is applied directly after enucleation to treat odontogenic keratocyst, and it is applied directly after unilocular ameloblastoma enucleation¹⁸. This reduces the likelihood of recurrence compared to when enucleation alone.

Carnoy's solution removes epithelial lining and daughter cysts by chemical necrosis up to 1.5 mm, which was first used in the 19th century⁷. Theoretically, this solution aids in the nucleus fixation of the residues of dental lamina, the cystic epithelium, and the epithelial structure of the daughter or satellite cyst. After the application and subsequent wash-out of Carnoy's solution, brown, denatured bone was exposed. Depending on the operator, this bone may be drilled out or left untouched⁹. Carnoy's solution is applied for 3 to 5 minutes after enucleation to prevent damage to the inferior alveolar nerve. However, due to the risk of neurological complications in the mandible, the application of Carnoy's solution adjacent the neurovascular should be careful. Lesions adjacent to the inferior alveolar nerve or the mandible boundary should be taken as preventive measures. Bone wax or gauze can be applied to protect the inferior alveolar nerve. However, these studies lack explanatory information on the degree of neuropathy and statistical correlation with surgery and require deeper clinical studies⁷. We added gauze and applied Carnoy's solution for 3 minutes to reduce the possibility of inferior alveolar nerve damage.

As another problem, chloroform, one of the components of the Carnoy's solution, was classified as carcinogen, and in 1992, US Food and Drug Administration banned it from being used as a combination treatment¹⁰. And the FDA banned the use of Car-

noy's solution, which are expected to be human carcinogens, in 2013 according to animal studies¹².

Modified Carnoy's solution excluding chloroform was applied, which rather led to the confirmation that chloroform was needed¹⁰. A retrospective study by Dashow et al. found a 35% increase in recurrence rates for modified Carnoy's solution, while an 11% increase for Carnoy's solution, concluding that chloroform may be an essential component of the solution¹². That is why the use of chloroform-containing drugs in FDA has been prohibited due to the lack of evidence for the effectiveness of modified Carnoy's solution, but surgeons have been using Carnoy's solutions¹⁴.

The use of modified Carnoy's solution is limited because the cortical bone is perforated, and the daughter cyst remains after enucleation, so there is a possibility of recurrence². The recurrence rate is 25~67%¹¹. Modified Carnoy's solution fixes and dehydrates the tissues around the lesion, and it is used to remove residual daughter cysts. Acetic acid can damage the surrounding peripheral nerve with permanent nerve damage ranging from 10 to 25%¹¹. Due to the high recurrence rate and nerve damage, an alternative material was considered: 5-fluorouracil. 5-FU is a topical cream, a chemotherapy drug with a mechanism that interferes with cell division and DNA replication processes in rapidly growing cells¹¹. It is applied to the cyst cavity for 24 hours after cyst enucleation, and it is believed to lower the OKC recurrence rate, and the incidence of permanent peripheral nerve damage is 0~10%¹¹. 5-FU is inexpensive, has a short preparation time, and can be stored for a long time, while modified Carnoy's solution must be prepared when necessary and is not suitable for long-term storage. Although 5-FU is considered to be a better drug in terms of recurrence rate and nerve damage, papers comparing 5-FU and modified Carnoy's solution are limited, so further research is needed¹¹. Therefore, referring to the necessity of chloroform and the lack of research results on the use of 5-FU in the comparative study between Carnoy's solution and modified Carnoy's solution, Carnoy's solution was used in this case.

In addition, there is a debate about when to make the Carnoy's solution before using it. Some researchers say it should be used within two days of mixing, while others say it can be stored for months⁹. Because the timing of mixing the Carnoy's solution does not significantly affect the outcome of treatment, we made and used Carnoy's solution in advance a few days before surgery to shorten the operation time and reduce the time of exposure to

bad smells.

In the case of cortical bone perforation, another treatment method is to resect the close periosteum and soft tissue⁷. This is based on the locally aggressive characteristics of odontogenic keratocysts, where the epithelium of the cyst penetrates the basal layer and forms a daughter cyst. The periosteum, a type of connective tissue, binds to the epithelium of odontogenic keratocysts and the lesions recur. The insufficient periosteum and soft tissue are reinforced using the local flap⁷.

A more aggressive treatment method is resection to reduce recurrence, but there is an increase in morbidity and a problem that requires reconstruction¹². In this case, resection was not selected as a treatment method because the patient was young, and the size of the lesion was not extensive.

The recurrence of odontogenic keratocysts occurs most frequently within 5~7 years of first surgery. The incidence of recurrence increased significantly within the first 5 years after surgery and decreased from 10 to 40 years after surgery. Therefore, follow-up should be focused for the first 5 to 7 years after surgery, and an annual examination should be conducted for follow-up⁸.

CONCLUSION

It is inappropriate to treat odontogenic keratocysts using conservative methods alone, and the recurrence rate can be reduced only when adjuvant therapy is used together. Carnoy's solution is used as an adjuvant therapy to treat OKC and other benign lesions⁵. It is a fixed cauterizer that penetrates the cancellous space of the bone and demineralized residual tumor cells to help regenerate the bone after surgery². It also reduces the recurrence rate by removing the lining epithelium. Osteotomy had the lowest recurrence rate, but it was too invasive for the patient and was not selected in this case. Instead, we used Carnoy's solution, which requires long-term follow up and reporting. It is recommended to follow up regularly after treatment, and panoramic radiographs should be taken. To reduce recurrence rate and morbidity, a systematic approach is needed based on the factors presented and solid evidence-based treatment options. In addition, follow-up for 10 years is recommended to check for recurrence, and close follow-up is required if recurrence is confirmed⁶.

REFERENCES

1. 대한구강악안면병리학회, 구강악안면병리학 제3판, 대한나래출판사,

2023년.

2. Kumar M, Tripathi A, Singh G, Singh A, Gupta A, Kasrija R. The role of adjunctive chemical solutions in the treatment of odontogenic keratocysts: a scoping review. *Cureus*. 2023;15:e41822.
3. Pylkkö J, Willberg J, Suominen A, Laine HK, Rautava J. Appearance and recurrence of odontogenic keratocysts. *Clin Exp Dent Res* 2023;9:894-898.
4. Titinchi F. Protocol for management of odontogenic keratocysts considering recurrence according to treatment methods. *J Korean Assoc Oral Maxillofac Surg* 2020;46:358-360.
5. Rao K, Kumar S. The use of enucleation and chemical cauterization(Carnoy's) in the management of odontogenic keratocyst of the jaws. *Indian J Otolaryngol Head Neck Surg* 2014;66:8-12.
6. Jung HD, Lim JH, Kim HJ, Nam W, Cha IH. Appropriate follow-up period for odontogenic keratocyst: a retrospective study. *Maxillofac Plast Reconstr Surg* 2021;42:16.
7. Francesco G, Caterina B, Daniele P, Stefano B, Valeria M, Antonio T. Factors influencing the recurrence of keratocysts: monocentric study. *J Oral Med Oral Surg* 2020;26:1.
8. Fidele NB, Yueyu Z, Zhao Y, Tianfu W, Liu J, Sun Y, Liu B. Recurrence of odontogenic keratocysts and possible prognostic factors: Review of 455 patients. *Med Oral Patol Oral Cir Bucal*. 2019;24:e491-501.
9. Pogrel MA. The keratocystic odontogenic tumor. *Oral Maxillofac Surg Clin North Am* 2013;25:21-30.
10. Peacock ZS. Adjunctive strategies for benign maxillofacial pathology. *Oral Maxillofac Surg Clin North Am* 2019;31:569-578.
11. Jacobs T, Patil D, Shanti R, Ziccardi VB. Comparing 5-Fluorouracil Versus Modified Carnoy's solution for the treatment of odontogenic keratocysts: A systematic review and meta-analysis. *J Oral Maxillofac Surg* 2024;82:1433-1440.
12. Donnelly LA, Simmons TH, Blitstein BJ, Pham MH, Saha PT, Phillips C, et al. Modified Carnoy's compared to Carnoy's solution is equally effective in preventing recurrence of odontogenic keratocysts. *J Oral Maxillofac Surg* 2021;79:1874-1881.
13. Ireland R, Yeung CA. Oxford University Press, A Dictionary of Dentistry 2 ed, Oxford University Press. 2020.
14. Ecker J, Horst RT, Koslovsky D. Current Role of Carnoy's Solution in Treating Keratocystic Odontogenic Tumors. *J Oral Maxillofac Surg* 2016;74:278-282.
15. Luz DA, Ribeiro U Jr, Chassot C, Collet E Silva Fde S, Cecconello I, Corbett CE. Carnoy's solution enhances lymph node detection: an anatomical dissection study in cadavers. *Histopathology* 2008;53:740-742.
16. Kamitani Y, Kurumi H, Kanda T, Ikebuchi Y, Yoshida A, Kawaguchi K, et al. Comparative study between histochemical mucus volume, histopathological findings, and endocytoscopic scores in patients with ulcerative colitis. *Medicine (Baltimore)* 2023;102:333033.
17. Miething F, Hering S, Hanschke B, Dressler J. Effect of fixation to the degradation of nuclear and mitochondrial DNA in different tissues. *J Histochem Cytochem* 2006;54:371-374.
18. Lee PK, Samman N, Ng IO. Unicystic ameloblastoma—use of Carnoy's solution after enucleation. *Int J Oral Maxillofac Surg* 2004;33:263-267.