

Using Carnoy's Solution in Treatment of Keratocystic Odontogenic Tumor

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Abstract

Aim: The aim of this study was to assess the treatment of keratocystic odontogenic tumor using enucleation and Carnoy's solution with peripheral ostectomy. **Materials and Methods:** Twenty-nine patients (14 females and 15 males) with age range from 12 to 62 years were included in this study and followed up for 7 years; all the patients were treated in the Department of Oral and Maxillofacial Surgery of the Specialized Surgeries Teaching Hospital (Al-Shaheed Ghazi Al-Hariri Hospital-Medical City, Baghdad, Iraq). Enucleation followed by peripheral ostectomy and the application of Carnoy's solution is the standardized method of treatment. **Results:** This study showed (32.7%) unilocular radiolucency for the lesions (19.9%) as multilocular radiolucency. Furthermore, it showed that the recurrence rate by this method was 0% with a minimum neurosensory disturbance. **Conclusion:** The complications and morbidity originating from the application of Carnoy's solution occurred less frequently and were less serious than those associated with resection while the recurrence rate is 0% which is equal to the recurrence rate of resection.

Keywords: Carnoy's solution, keratocyst, keratocystic odontogenic tumor

INTRODUCTION

The keratocystic odontogenic tumor (KCOT), previously known as odontogenic keratocyst, has a great deal of interest in the literatures due to its high recurrence rate, locally aggressive behavior which grow to a large size before it detects clinically, and it's characteristic histological appearance. There are many evidence that support this term, and to classify it as "a benign uni- or multi-cystic, intraosseous tumor of the odontogenic origin, and Toller, 1967 suggested that the epithelial linings of the keratocyst has intrinsic growth potential and he was the first to suggest that there was some basis for regarding it as benign neoplasm.^[1-4] Most KCOT recurrences can be diagnosed within the first 3 years of follow-up. In spite of the fact that many treatment modalities had been developed for the treatment of the KCOT, the risk of the morbidity and the recurrence rate is still high, and also there is always balancing between the recurrence rate and the complications that is associated with the method that has been used for the treatment of KCOT.^[5-8]

Enucleation with peripheral ostectomy and Carnoy's solution

Enucleation with peripheral ostectomy and Carnoy's solution technique refers to surgically husking the tumor out of the bone to remove the entire lesion without leaving any macroscopic remnant. This is followed by a reduction in peripheral bone with powered handpiece and application of Carnoy's solution. Moreover, to the best our knowledge, there is only one series in the literature consisting of 13 patients treated by this method and shows 0% recurrence rate.^[9]

Carnoy's solution was first described by Cutler and Zollinger, 1933 as a treatment for cystic lesions and fistulae; also currently, its use in the treatment of unicystic ameloblastoma and in ossifying fibroma is also reported in the literature. It is also likely to penetrate cancellous spaces and thus devitalize

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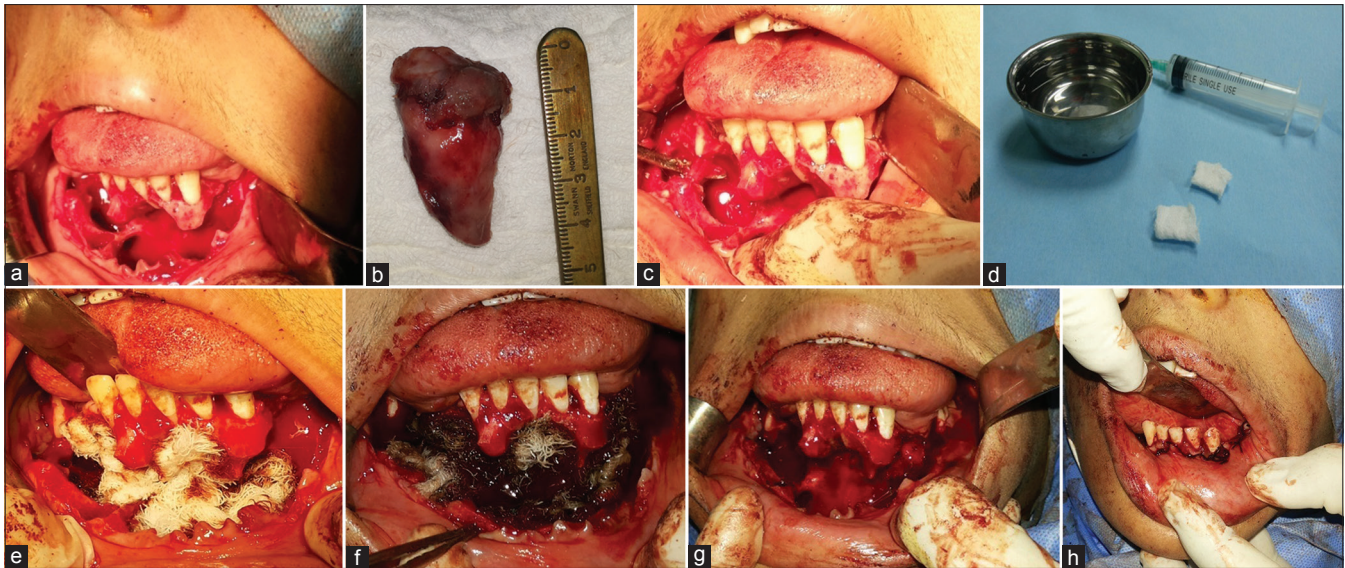


Figure 1: (a) Intraoral approach, mucuoperiosteal flap reflection and enucleation. (b) Enucleation of the keratocystic odontogenic tumor. (c) The inferior alveolar bundle (arrow) exposed and protected to be isolated during peripheral ostectomy and the application of Carnoy's solution. (d) Carnoy's solution. (e) Application of the Carnoy's solution in the bony defect after peripheral ostectomy. (f) When the 3 min of the application is elapsed, immediately before gauze removal, showing the change in the color of the gauze due to cauterization and fixation action of the solution. (g) Before wound closure. (h) Iodoform packing then suturing



Figure 2: Unilocular radiolucency with anterioposterior cortical and cancellous expansion

and fix the remaining tumor cells; Carnoy's solution composed of 1 g of ferric chloride [FeCl_3] dissolved in 6 ml of absolute alcohol, 3 ml of chloroform, and 1 ml of glacial acetic acid; the reformulated Carnoy's solution without chloroform is currently generally accepted because exposure to chloroform has been associated with cancer and reproductive toxicity.^[10] The solution can be applied inside the cystic lesion or, more commonly, directly over the remaining bone bed after the lesion has been removed. The success of the application of this agent after enucleation was thought to be due to both of its penetration and fixation action. The usual practice is to apply Carnoy's solution with cotton applicators or ribbon gauze for 3–5 min, rinse the bony defect, and pack the wound open for healing by secondary intention. Some investigator reported some complication resulting from the use of Carnoy's solution although that some doubt still remains regarding them, this complications include infection, dehiscence, bone sequestrum formation, and neuropathy.^[11,12] Frerich *et al.*, 1994 suggested that the application of Carnoy's solution should not exceed 3–5 min. They showed that the critical time to nerve

impairment of the rabbit inferior alveolar nerve was 3–5 min, and that Carnoy's solution should not be applied directly over the nerve. It is concluded that any damage happened to the blood vessels is reversible when the exposure times are <5 min.^[13,14]

Hence, this study tried to share the experience and to assess the treatment of KCOT using enucleation and Carnoy's solution with peripheral ostectomy.

MATERIALS AND METHODS

The sample and materials

In this study, 29 patients (14 females and 15 males) with age range from 12 years to 62 years were included and followed for 3–6 years; all the patients were treated in the Department of Oral and Maxillofacial Surgery of the Specialized Surgeries Hospital (Al-Shaheed Ghazi Al-Hariri Hospital, Medical City, Baghdad, Iraq).

The KCOT in the mandible which is extended into the condylar and coronoid processes or near the base of the skull in the maxilla was excluded from this study, and also the Gorlin–Goltz syndrome (basal cell nevus syndrome) was also excluded from the study.

The presenting symptoms were pain, neurosensory disturbance, teeth mobility, and bony expansion. Patients were completely assessed, including history, clinical examination of the intra- and extra-oral examination, laboratory assessment, radiographic studies (plain radiographs, panoramic radiograph and computerized tomography scans according to its availability), and biopsy for each patients for histopathological studies. Once these



Figure 3: Keratocystic odontogenic tumor with multilocular radiolucency in the central region (symphyseal and parasymphyseal) of the mandible

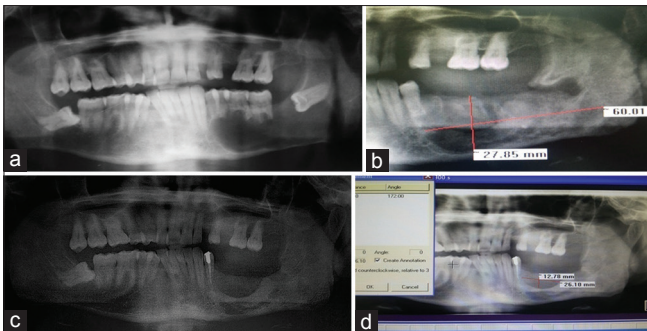


Figure 5: (a) Preoperative radiograph for 47-year-old male patient with a huge unilocular radiolucency (arrow), this case was prepared to be treated by other treatment modalities (jaw resection) in another hospital. However, it was included in this study and treated by enucleation with peripheral ostectomy then Carnoy's solution application. (b) The bony defect in millimeter, 7 days postoperatively. (c) Follow-up of more than 3 years shows the bone regeneration at the surgical site although we use Carnoy's solution. Furthermore, it shows no recurrence. (d) The defect in millimeter during follow-up periods (decreased)

investigations were completed, informed consent was taken, and the patient fitted for surgery, the following surgical technique performed:

1. All the cases in theater done under general anesthesia by oral or nasal intubation while the patient in supine position, throat pack is used to avoid pulmonary aspiration, the intraoral incision is used as our approach to the KCOT using two-sided or three-sided mucoperiosteal flap according to the site, size, and the extension of the tumor, when the incision is complete, a periosteal elevator (Howarth's periosteal elevator) is used for a full mucoperiosteal flap reflection, a bone window was made to expose the KCOT which should be always made large enough to give a good visibility and access to the tumor
2. Extraction for the involved teeth that showing roots resorption to facilitate tumor removal and do not leave any tumor remnants and this will lead to decrease the recurrence rate. After that, the enucleation is done [Figure 1a and b]. Moreover, if the inferior alveolar nerve was exposed during the enucleation procedure, especially in the molar area of the mandible;

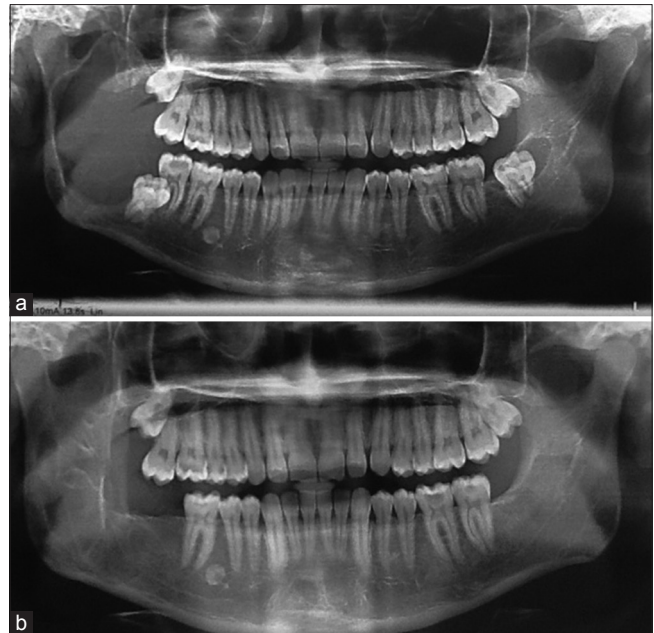


Figure 4: (a) Preoperative radiograph for 19-year-old male patient with keratocystic odontogenic tumor at the right side of the ramus of the mandible (arrow), date of photograph: October 2011. (b) The same case during the follow-up in January 2015, the bone continuity was restored and there was no recurrence (it was treated in October 2011 by enucleation with peripheral ostectomy then Carnoy's solution application)

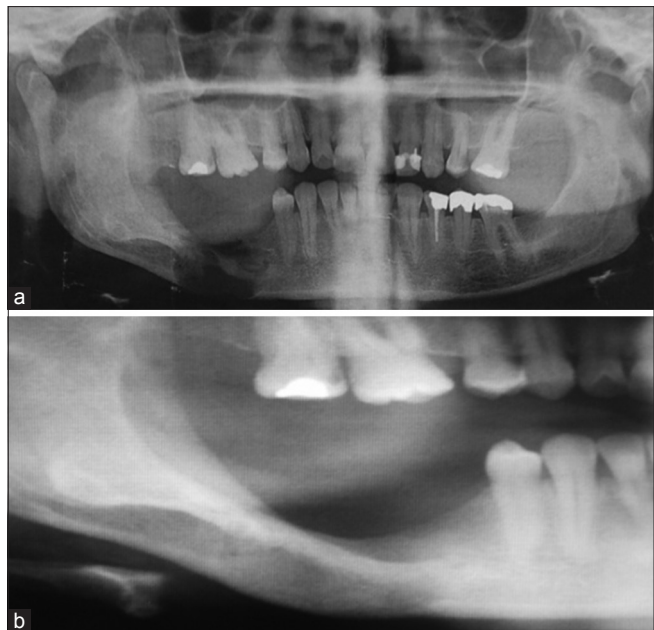


Figure 6: (a) Preoperative radiograph for a female patient, operated previously and show recurrence within less than a year. (b) Panoramic radiograph after more than 2 years postoperatively, the bony defect is totally filled by regenerated bone

in this case, the KCOT was carefully stripped from the nerve which was preserved and isolated with tapes [Figure 1c]

3. Peripheral ostectomy: to reduce the bony cavity (margins) using a powered handpiece and to remove any bone

spicules, septa, or scalloping in the bone, with an irrigation with normal saline

4. Carnoy's solution application: The solution (1 g of FeCl₃ dissolved in 6 ml of absolute alcohol and 1 ml of glacial acetic acid without chloroform) was applied to the bony defect for 3 min using cotton applicator or ribbon gauze (1 cm³ in size) soaked with the solution if there is large lesion so multiple pieces of (1 cm³ in size) prepared and inserted together. This was followed by copious irrigation with normal saline and constant suctioning [Figure 1d-f]
5. Closure: In most cases, the bismuth iodoform paraffin paste (BIPP) impregnated gauze (iodoform gauze) is inserted into the bony defect leaving a small length of this gauze outside the bony cavity to be removed after 6 days without replacement to prevent infection and support suturing if the crestal alveolar bone has been lost due to extraction. Primary healing was permitted through continuous 3/0 silk suturing [Figure 1g and h]
6. Follow-up: Regular radiographic follow-up is essential. Recurrence also evaluated during the follow-up visits (1 week, 1 month, 3 months, 6 months, 1 year, 2 years, and more) postoperatively by a clinical examination to check any clinical manifestation as that found during the first presentation and by panoramic radiography to check any new osteolytic area found in the operative site, to reevaluate it using computerized tomography and/or biopsy to confirm the recurrence.

Statistical analysis

In this study, SPSS15 Inc. (Chicago, IL) is used for statistical analysis and Excel-10 is used for tables.

1. Tables, descriptive numbers, percentage
2. Inverting statistics
 - Chi-square
 - Z-test
 - P value; if $P < 0.05$ statistically significant.

If $P > 0.05$ nonsignificant.

If $P < 0.001$ highly significant.

RESULTS

This clinical study included 29 patients, 15 (51, 72%) males and 14 (48.27%) females and with age ranging from 12 to 62 years. The mandible was involved in 25 patients (14: males, 11: females); while the maxilla was involved in 4 patients (1: males, 3: females) as shown in Table 1.

Furthermore, the left side in both jaws was the predominant side for the KCOT as shown in Table 2.

At the time of the presentation, nine patients showed a neurosensory disturbance, seven patients with a recurrence of KCOT, and they were treated by other methods of treatment differ from decompression, marsupialization, or enucleation. One of the patients was subjected to more

Table 1: Jaw distribution

Site	Male (%)	Female (%)	Total (%)
Maxilla	1 (3.44)	3 (10.34)	4 (13.79)
Mandible	14 (48.27)	11 (37.93)	25 (86.20)
Total	15 (51.72)	14 (48.27)	29 (100)

* $\chi^2=29.02$, $P<0.001$ HS. HS = High significant

Table 2: Anatomic location (site)

Site	Left side (%)	Right side (%)	Central (%)	Total (%)
Maxilla	4 (13.7)	0	0	4 (13.7)
Mandible	11 (37.9)	9 (31)	5 (17.2)	25 (86.2)
Total	15 (51.7)	9 (31)	5 (17.2)	29 (100)
χ^2 ***	16.111	$P<0.001$ **	$P<0.001$	29.02
P	0.01	HS	HS	$P<0.001$ (HS)
	$P<0.05$ *			

* $P<0.05$ significant, ** $P<0.001$ HS, *** $\chi^2=2.845$, $P=0.048$, $P<0.05$ significant of left, right, central. HS = High significant

than 5 different operations and the recurrence was also occurred after each one of them. The radiographic studies for the 29 patients showed that 18 patients with unilocular radiolucency [Figure 2] and 11 patients with multilocular radiolucency [Figure 3].

In this clinical study, 9 cases showed a dehiscence in the surgical site postoperatively and 11 cases showed a neurosensory disturbance. All the 29 cases show no recurrence during the follow-up periods [Table 3].

DISCUSSION

This clinical study revealed a slight difference in frequency of the gender in males and females (51, 72% males and 48, 77% females); hence, the lesions occur about equally in both sex, while in Woolgar *et al.*, 1987a, b series, the gender distribution of patients with solitary lesion shows a high incidence of males (62% males and 38% females). The age ranging from 12 to 62 years agrees with Meara *et al.*, 1996 which records a wide age range for the patients.^[15-17] Furthermore, this study showed that the mandible is involved far more frequently than the maxilla (86% mandible and 14% maxilla - $\chi^2 = 29.02$ $P < 0.001$ highly significant), and this high frequency of mandibular involvement coincide with data found in other series, 78%; 62% and 73%.^[5,18,19] However, this study shows a slight higher frequency than the others. Regarding the relation of the anatomic location to the gender, the males were more involved than females in the mandible (48% males and 38% females), while in the maxilla, the females were more involved than males (3% males and 10% females). The predominant side in mandible and maxilla in this study is the left side (52% left side, 31% right side, and 17% middle) ($\chi^2 = 2.845$ $P = 0.048$ $P < 0.05$ significant of left, right, midline).

Patients at time of presentation were complained of swelling, sensory disturbance, and teeth mobility. Importantly, this

Table 3: Treatment and outcome

Number of cases	Treatment technique	Recurrence*	Dehiscence	Sensory disturbance
28	Enucleation + peripheral Ostectomy + Carnoy's Solution	No recurrence	9	11
1	Resection + Carnoy's solution*	No recurrence	0	1

* $\chi^2=21.182$, $P<0.001$ HS. HS = High significant

study shows a high incidence of gingival swelling (23%) and facial swelling (12.5%) (Z -test 6.492 $P = 0.01$ $P < 0.05$ significant), this refers to the frequency of bone expansion, and this agrees with the study of Brannon, 1976, who reported a 25% frequency of bony expansion; hence, this findings differ from the existing knowledge that the KCOT grows within the medullary cavity of the jaw without bone expansion.^[20,21]

Radiographically, a unilocular radiolucent area which has a well-defined and often sclerotic border founded in 18 cases with a 62% of all cases (Z -test 7.120 $P = 0.006$ $P < 0.05$ significant), and here, we commonly depend on the panoramic radiographs (orthopantomogram); furthermore, this study agrees with Van Rensburg, 2003 who reports that although the panoramic radiograph reveals the location and expansion nature of the lesion, they did not help in determining the locularity or extent of the lesion within the jaws.^[22]

The study showed that the incidence of recurrence by other methods of treatment is 14.5%, this related to the number of cases referred to our department and gave a history of previous surgical operations. Forssell, 1980, found a recurrence in 13%, 24%, and 35% during years 1, 2, and 3, respectively, for the KCOT cases which treated with enucleation or curettage and without complementary treatment.^[5] Moreover, the majority of the recurrence are expected to be detected before the third postoperative year.^[23]

Twenty-eight patients were treated by enucleation with peripheral ostectomy than Carnoy's solution application; moreover, to best our knowledge, there is only one series in the literature consisting of 13 patients with KCOT treated by this method.^[9,19] Furthermore, we treated only 1 case by resection and application of Carnoy's solution at the ostectomy sites and that due to the resorption of the inferior border of the mandible, cortical perforation and the involvement of the coronoid and the condyle by the KCOT. Blanas, 2000, undertook an extensive review for KCOT treatment, 14 papers were selected that met the authors' strict inclusion criteria and 578 cases were included, he concluded that simple enucleation resulted in a recurrence rate (28.7% of 387 cases), adding Carnoy's solution to the cyst cavity for 3 min after enucleation results in a recurrence rate comparable to that of resection without necessarily aggressive surgery (1.6% of 60 cases).^[7] This study and by performing the peripheral ostectomy after the enucleation and then the application of Carnoy's solution to the bony defect, the recurrence rate was 0% during the follow-up period which extend from 3 to 6 years, which is the preferred period for follow-up cause the majority of the

recurrence in KCOT are expected to be detected before the third postoperative year.^[5,23] Hence, this procedure appeared to be a minimal invasive procedure with the lowest recurrence rate [Figure 4].

Furthermore, this study shows that although Carnoy's solution is a fixative agent penetrates cancellous spaces in the bone and thus devitalizes and fixes the normal and tumor cells in the bone, bone regeneration take place in the bony cavity of the jaws postoperatively and the defect in the continuity of the jaws was restored and this is one of the main advantageous results founded in this study as shown in Figures 4-6.

Neurosensory disturbance found in 11 cases, one of them was due to the ostectomy of the bone (bone resection) while another case shows a tender tooth with jaw pain and this case was treated by endodontic treatment to this tooth and after that, the pain was resolved, and the other 9 cases show a paresthesia of the lower lip and chin area of the operation site and we could not figure it clearly if it is related to the effect of the Carnoy's solution or if its related to the previous operation cause 9 cases show a neurosensory disturbance at the time of the presentation. Dehiscence at the surgical site was found in 9 cases postoperatively with wound break down, and this is may be attributed to the lack of support to the roof of the cavity due to bone removal from the alveolus by enucleation, peripheral ostectomy, teeth extraction or Carnoy's solution usage, this complication was treated by bony defect irrigation by normal saline (intravenous fluid) then packing the wound with BIPP impregnated gauze which changes at weekly interval (3-4 times) until secondary healing was complete. Ribeiro Júnior *et al.*, 2007, show in their studies that the dehiscence related to Carnoy's solution occurred in 22.7% of their cases, and here, we match with this results.^[12]

Apart from the case treated by resection, no facial scaring was found cause all the operations of the other cases done through intraoral approach. No fracture occurred postoperatively and all the cases treated through one-stage procedure.

CONCLUSION

It can be concluded that the combination of treatment with enucleation and peripheral ostectomy then the application of Carnoy's solution to the bony cavity for no more than 3 minutes, appears to be efficient for treating of KCOT by diminishing the recurrence rate to 0% during the most critical period (the first 3 years) and its equal to that of the

resection. The complications and morbidity originating from the application of Carnoy's solution occurred less frequently and were less serious than those associated with resection.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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