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Conservative Treatment of Mandibular Odontogenic Keratocysts - A Clinical Study

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Abstract

The aim of this study is to evaluate the efficacy of Carnoy's solution in the treatment of mandibular Odontogenic keratocysts. The clinical study included a sample size of 7 patients who reported to the department of oral and maxillofacial surgery for treatment of Odontogenic keratocysts under local or general anesthesia. All the cystic lesions were surgically treated with enucleation followed by application of carnoy's solution to the cystic defects. The patients were followed up for a period of 6 months. The parameters assessed were postoperative infection, dehiscence, recurrence, sequestrum formation and neuropathy.

Keywords: Odontogenic Keratocysts, Keratocystic Odontogenic Tumor, Enucleation, Carnoy's Solution

Introduction

Odontogenic keratocyst (OKC) is an enigmatic developmental cyst that Mikulicz first described in 1876. In 1926, it was first known as "cholesteatoma," which means a cyst or open mass of keratin squames with a lining matrix. Philipsen, in 1956, along with Jens J Pindborg, named and described 'odontogenic keratocyst'[1]. Pindborg and Hansen first pointed out the aggressive behavior of OKC. Shear described the aggressive nature of OKC and labeled it as a benign cystic neoplasm. He named OKC as "keratocystoma." Regezi and others explained the pathogenetic mechanisms of OKC. According to them, mechanisms that favor the growth and expansion of OKCs are high proliferation rate, overexpression of anti-apoptotic proteins (bcl-2) and matrix metalloproteinase (MMPs 2 and 9) expression.[2]. In 2005, WHO changed the term Para keratinized OKC to the keratocystic odontogenic tumor, and orthokeratinized variety continued as KCOT. WHO defined keratocystic odontogenic tumor (KCOT) as a benign, unicystic, or multicystic intraosseous tumor of odontogenic origin, with a characteristic lining of Para keratinized stratified squamous epithelium with a potential for aggressive, infiltrative behavior.[3] However, the WHO consensus group suggested that there was insufficient evidence to support a neoplastic origin of KCOT and decided that the OKC remains the most

appropriate name for this lesion in the new 4th edition[4]. In 2017, WHO classification accepted the terminology of OKC as many papers showed that PTCH gene mutation could also be found in other non-neoplastic lesions, including dentigerous cyst and resolution of cyst after marsupialization was not compatible with a neoplastic process. The 2017 classification has reverted the terminology of KCOT to OKC[5].

OKC comprises approximately 2% - 21.8% of all jaw cysts[4], and 3 %-11% of odontogenic cysts. OKC arises from remnants of the dental lamina. OKC occurs mainly in the 2nd and 3rd decades and its prevalence is higher in men than women. They occur in either or both jaws, with most lesions occurring in the mandible, more commonly in the posterior body and ascending ramus[6]. OKCs follow the path of least resistance and hollow out a good part of the mandible replacing the bone marrow or extend into the maxilla close to the base of the skull[7]. They are usually asymptomatic but may show clinical features like pain, soft tissue swelling, infection, paresthesia of the lip or teeth. Pathological fractures occur when OKC extends into the medullary cavity and expands at a later period[3,8]. OKCs tend to grow anteroposterior Ly through the bone marrow spaces before the appearance of any significant buccal or lingual expansion[6,8]. Multiple OKCs are associated with nevoid basal cell carcinoma syndrome. Radiographically, OKCs present as a well-defined radiolucent lesion with smooth and usually corticated margins[7]. Radiographic presentation is categorized into four types: Unilocular (a more or less round configuration with or without well-defined radiopaque margins), scalloped (radiolucency with a festooned margin), multilobular (two or more lobes no bony septae dividing the lobes), multilocular (separate locules divided by bony septae)[7]. Aspiration biopsies revealing keratin flakes are helpful in diagnosis. Inflammatory reaction precludes a correct cytological diagnosis as OKCs tend to undergo metaplastic changes when inflammation occurs. When the cyst's protein content is less than 4g/100ml, the diagnosis is reasonably secure, but inflammation increases the protein content, giving rise to false-negative diagnoses[7]. OKC's histological criteria, as described by WHO, are characterized by a thin fibrous capsule and a lining of keratinized stratified squamous epithelium, usually about 5-8 cells in thickness without rete pegs[7].They show a thin band-like Para keratinized or orthokeratinized stratified squamous epithelium, with a prominent palisaded and hyperchromatic basal cell layer composed of either columnar or cuboidal cells and connective tissue wall that is usually free of inflammation[5,6]. Parakeratotic variants account for 83%-97% of OKCs and have tremendous potential for localized destruction, extension into the adjoining tissues, rapid growth, recurrence, and diversity. The orthokeratotic variant is a less aggressive one with a low recurrence rate ranging from 3.3 to 12.2%[3]. Stoelinga et al[7] demonstrated the accumulations of epithelial islands in the mucosa superficial to the excised keratocyst, especially in the ascending ramus (dropping off phenomenon). The remnants of these epithelial islands left behind in the overlying mucosa cause recurrence of the cyst. The majority of epithelial islands, as found in the wall of OKCs, are attached to the mucosa that covers the pathological tissue. Therefore, excision of overlying mucosa along with the cystic removal must be considered to prevent recurrence of the cyst[3].

The issue of appropriate treatment of OKCs remains a subject of controversy. The ideal treatment of OKC is the subject of much debate among surgeons. However, treatments known to be conservative have yielded good

outcomes when used with a complementary therapy of the surgical bed, such as excision of soft overlying tissue, peripheral ostectomy, cryotherapy, and carnoy's solution[8,9]. The spectrum of treatment modalities is broadly divided into two categories, conservative and aggressive approaches. Conservative approaches include decompression or marsupialization, simple enucleation with or without curettage, and aggressive procedures including enucleation with peripheral ostectomy or Carnoy's solution, cryotherapy and resection (en-bloc or marginal). Decompression causes the cyst wall to become thicker and more orthokeratinized, resembling normal oral mucosa without OKC's inherent aggressive features. Marsupialization causes complete resolution of the lesion and cyst disappearance. This procedure is followed by cyst enucleation. Common indications for marsupialization of OKCs include a large cyst size, significant collateral hard and soft tissue trauma associated with enucleation surgery, the difficulty of surgical access, assistance in teeth eruption, and an age-related conservative surgical option (children, elderly patients). Limiting factors of this technique include the prolonged time it takes to eradicate the lesion and the possibility of cyst recurrence. Enucleation is the most commonly used method to treat OKCs. Enucleation with peripheral ostectomy refers to surgical removal of the lesion by enucleation, followed by a reduction in peripheral bone in the cavity. It is done with a powered handpiece to remove the entire lesion without leaving any macroscopic remnants. This technique is less precise and carries a high risk of field contamination by driving daughter cells into the deeper layers of bone and adjacent soft tissue. Cryotherapy kills cells by direct damage to intracellular and extracellular surfaces because of the formation of ice crystals that affect the osmotic and electrolytic balance. The purpose of enucleation combined with liquid nitrogen cryotherapy is to remove the visible pathologic tissue and necrotize by freezing cell rests that may cause recurrence. Liquid nitrogen has cell-necrotizing properties and preserves inorganic bone structures, whereas Carnoy's solution destroys osteogenic and osteoconductive properties. The recurrence rates of OKC are low when treated with this technique[8]. The complications of this technique include- reversible nerve lesions, pathologic fractures, suture dehiscence, and sequestrum formation. These complications occur owing to deep bone necrosis and the possibility of accidentally freezing the periosteum in nonfenestrated areas. The high amplitude of cryotherapy makes it useful for treating other neoplasms and appears unnecessary for treating OKCs[8,9]

Carnoy's solution is a caustic tissue fixative used to kill the epithelial islands or daughter cysts on direct application. It is applied immediately after enucleation. The first reported use of carnoy's solution was in 1973. In the early 20th century, its benefit in surgical procedures for cystic lesions was initially described. Carnoy's solution is a cauterizing agent with moderate tissue penetration, rapid local fixation and hemostatic action. The solution can be applied inside the cystic lesion or more commonly directly over the remaining bone bed after the lesion is removed. Its application over the bone provides a safety margin for treating invasive neoplasms and produces superficial necrosis up to 1.5mm deep. (Williams and Cannor, 1994; Lee et al., 2004). Every 10ml of solution contains 6ml of 95% ethanol, 3ml of chloroform, 1ml of glacial acetic acid, and 1gm of ferric chloride (Voormsit et al. 1981)[10]. Enucleation refers to surgically husking the tumor out of the bone to remove the entire lesion without leaving any macroscopic

remnants[11]. It shows high recurrence rates because of difficulties associated with removing the lesion in one piece. The advantages of this technique include apparent precision of solution application and ease of treatment of cysts of any size. The disadvantages include irreversible neurotoxicity (on agent's exposure of about 2 minutes or longer to inferior alveolar nerve or lingual nerve), toxicity to adjacent soft tissue, skin and dental follicles, irreversible damage to the superficial and devitalized osseous margin, and no possibility of immediate grafting. The use of this technique significantly decreases the risk of OKC recurrence[12]. Simple enucleation has a recurrence rate of 17% to 56%. In comparison, simple enucleation combined with adjuvant therapy, such as the application of carnoy's solution, was reported to have a recurrence rate of 1% to 8.7%[13].

Resection is indicated when- 1) OKC recurs despite the previous enucleation with an adjunctive procedure; previous marsupialization followed by enucleation with an adjunctive approach 2)in cases of multilocular aggressive intraosseous OKC;3) in cases of NBCCS; 4) in a diagnosed OKC exhibiting aggressive clinical behavior(e.g., growth, destruction of adjacent tissues) should require resection as the initial surgical treatment. Three different types of resections (mostly performed on mandible) are - en bloc resection, marginal(segmental) resection without disruption of the bone continuity, partial resection with the continuity defect, and total resection (maxillectomy, mandibulectomy)[12]. Resection has the lowest recurrence rates amongst the various treatment options for OKCs, but when compared with other treatment modalities, it is associated with morbidities such as facial asymmetry and loss of jaw continuity. Therefore, resection is suggested for a large and recurrent lesion in different locations.

The clusters of epithelial islands and microcysts are present in the overlying mucosa, where the cyst penetrates through the bone. This is mainly seen in ascending ramus distal to the third molar or in the maxillary tuberosity area. So, it is necessary to excise the overlying, attached mucosa (EOM) and treat the bony defect with Carnoy's solution. This method eliminates two possible causes of recurrences. First, epithelial rests left behind from the cyst wall usually present in larger cysts (located in anatomically inaccessible areas). Second, clusters of epithelial islands and microcysts are eliminated[7]. In 1992, the American Food and Drug Administration (FDA) Compliance Policy Guide (chapter 4 subchapters 460) prohibited pharmaceutical compositions of therapeutic agents containing chloroform, which is considered a carcinogenic compound. Indeed, this guidance promoted chloroform replacement, and Carnoy's solution changed to the composition: 9-ml absolute ethanol, 3-ml acetic acid, and 1-g ferric chloride. Ethanol (CH2H5OH) presents coagulative fixative properties that denature insoluble proteins in the water at room temperature and extract phospholipids from cells without affecting the carbohydrates, principally when in significant concentration in the solution (described as solvent). Chloroform (CHCl3) enhances and accelerates ethanol penetration in the tissue. It is a compound with lipophilic nature that improves tissues' dehydration by dissolving the lipids in membranes, favouring ethanol's action in the process. The efficacy of Carnoy's solution without chloroform is reduced, leading to higher recurrence rates. Glacial acetic acid (CH3COOH) penetrates rapidly in tissues and has the role of preserving chromosomes through the coagulation of nucleic acids. Furthermore, this compound breaks the cross-links between proteins

and releases hydrophilic radicals, swelling the tissue, thereby preventing the excessive shrinking and stiffening promoted by ethanol. Ferric chloride (FeCl3) is a brownish chemical agent with acidic and protein coagulating properties, which provides its characteristics as a potent hemostatic agent. On the contrary of further known hemostatic agents, ferric chloride displays its effects through the chemical reaction with blood, regardless of the action of the standard hemostatic system. As most topical hemostatic agents are employed to control superficial bleeding, requiring normal hemostatic functions to achieve the effects, the addition of a local hemostatic agent that exempts the need for a normal hemostatic system may indeed improve the coagulative effect[14]. The possible complications resulting from carnoy's solution include infection, dehiscence, bone sequestrum formation, and neuropathy. The degree of neuropathy associated with carnoy's solution seems to depend on the contact time with the neural surface and the axonal degradation that occurs with treatment lasting longer than 3 min.

The incidence of recurrence of OKC has varied from 2.5% to 62%. In 1976, Brannon proposed three mechanisms for OKC recurrence: Incomplete removal of the cyst lining, growth of a new OKC from satellite cysts (or odontogenic rests left behind after surgery), and development of a new OKC in an adjacent area. The major histopathological features to predict recurrences in OKC are the higher level of cell proliferative activity in the epithelium, budding in the basal layer of the epithelium, Para keratinization of the surface layer, supraepithelial split of the epithelial lining, a subepithelial split of the epithelial lining, presence of remnants/cell rests as well as daughter cysts[2].Woolgar et al. described three different theories for recurrence. The first theory stated that the incomplete removal of cystic lining could be a cause for recurrence. The second theory described the small satellite cysts or odontogenic epithelial rests left behind after the surgical treatment. The third theory involved developing an unrelated KCOT in an adjacent region of the jaws considered recurrent[3]. Mutations in PTCH 1 (patched) gene is regarded as responsible for the pathogenesis of OKC. PTCH gene functions as a tumor suppressor gene and has been mapped for chromosome 9q22.3-q31. The PTCH1 is an essential molecule in the Hedgehog (Hh) signaling pathway. Usually, PTCH forms a receptor complex with the oncogene SMO ("smoothened") for the SHH ("sonic hegehog") ligand. There is molecular evidence of a two-hit mechanism in the pathogenesis of Nevoid basal cell carcinoma syndrome (NBCCS) and sporadic OKC. It demonstrates allelic loss, at two or more loci, of 9q22, leading to overexpression of bcl-1 and TP_{53} in NBCCS. This supports the concept that OKC represents a neoplasm. The epithelial lining of OKC expresses higher levels of P53 than any other cystic type. This overexpression is not due to the P53 gene's mutations, instead of reflecting overproduction or stabilization of P53 protein[2].

The treatment choice should be based on multiple factors: patient age, size and location of the cyst, soft tissue involvement, history of previous treatment, and a histological variant of the lesion. The goal is to choose the treatment modality with the lowest risk of recurrence and the least morbidity. In the present study, we have highlighted the outcomes of carnoy's solution after enucleation in patients diagnosed with OKC.

Materials & Methods

The clinical study included a sample size of 7 patients of either gender with age group between 18 - 60 years for

the treatment of OKC under local or general anesthesia. Each patient was given a brief description of the intended surgical procedure, and informed consent was taken.

Criteria for selection of the subjects

Patients involved in the study were those diagnosed as OKC histopathologically.

Inclusion criteria

- Patients in the age range of 18-60yrs.
- Patients diagnosed with OKC by histopathological evaluation.
- Patients diagnosed with OKC not involving inferior border of the mandible.

Exclusion criteria

- Patients with a peripheral (extraosseous) variant of OKC.
- Patients with nevoid basal cell carcinoma.
- Patients with medically compromised conditions (ASA class III and IV patients).
- Patients with multiple recurrent lesions.
- Patients with the invasion of soft tissue.

The clinical study included patients with cystic lesions demonstrating features of OKC. All necessary preoperative and postoperative records were maintained.

- Preoperative assessment
- Evaluation of demographic factors of patients like age and sex.
- Assessment of presenting symptoms of OKC like pain, swelling, infection, paresthesia, etc.
- Appropriate anatomical location of the lesion.
- Radiographic evaluation of lesion with OPG like unilocular, i.e., a more or less round configuration and with or without a well-defined radiopaque margin, or multilocular appearance, i.e., separate locules divided by bony septae.
- All the cystic lesions underwent histological evaluation prior to surgery.

Surgical technique

The procedure was done under all aseptic precautions. The surgical procedure was carried out under general anesthesia or local anesthesia (2% lignocaine hydrochloride with adrenaline in 1:80000 concentration). After standard disinfection and draping, the lesion was exposed by mucoperiosteal flap elevation and bone removal. The lesion was enucleated and teeth adhering to the lesion were removed. The overlying mucosa or periosteum in contact with OKC that fenestrated through bone was excised and removed. Adjacent soft tissues were protected with gauze. In case of nerve exposure, it was lifted out from its bony canal when treating with carnoy's solution to avoid nerve damage. A small gauze soaked with Carnoy's solution was picked up with a mosquito clamp. The gauze was applied for 5 minutes to the bony cavity and repeated several times until the whole defect is treated. The clotted blood and necrotic material covering the defect was scraped away and thoroughly washed out with saline. The defect was closed with resorbable sutures. Analgesics and antibiotics were prescribed postoperatively, and patients were recalled for a checkup. The patient was followed up for a period of 1week, 1month, 3 months, and 6 months. The parameters assessed were infection, dehiscence, recurrence, sequestrum and neuropathy (where the nerve is not in proximity to the lesion).

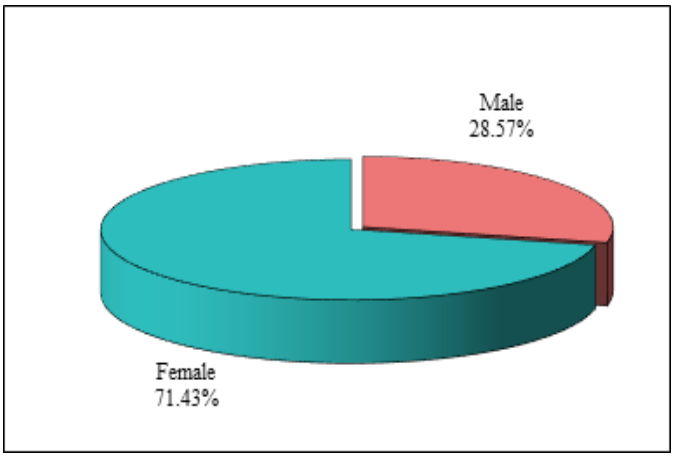
Postoperative Sensory Assessment

sensory assessment related to carnoy's solution was done in 1 week, 1 month, 3 months, and 6 months. Patients who presented with sensory impairment postoperatively were evaluated using a questionnaire and clinical tests. The clinical tests evaluated a 1cm area of an intermediate

portion of the lower lip skin below the vermillion. The evaluation methods were static light touch, two-point discrimination, brush directional discrimination, and pin pressure. The degree of paresthesia was assessed using a visual analog scale (VAS) ranging from 0 to 10 (0 = insensitive, 1-9 = paresthesia and 10 = normal). The unaffected side was used as a control with an equivalent value of 10. Paresthesia was subdivided into mild (7-9); moderate (4-6); severe (1-3) based on values of VAS.

Results

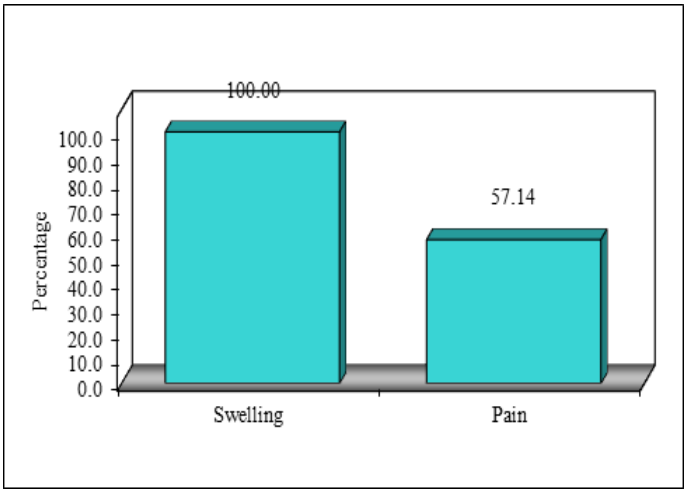
The clinical study consisted of a sample size of 7 patients with cystic swelling diagnosed as odontogenic keratocyst. Out of 7 patients, 2 were male with a mean age of 20.00 years, and 5 Female with a mean age of 32.00. [Graph 1].



Graph 1: Gender Wise Distribution of Patients.

Clinical Manifestations of the Lesions

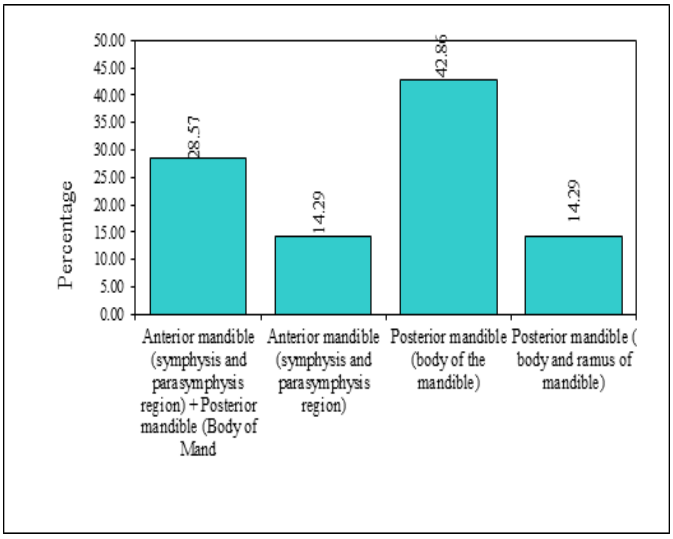
The clinical features included were pain and swelling. Almost all patients (a total of 7 patients) presented with swelling. Rest of the patients (4 patients) presented with pain, as shown in Graph 2.



Graph 2: Clinical Manifestations

Anatomical Location of the Lesion

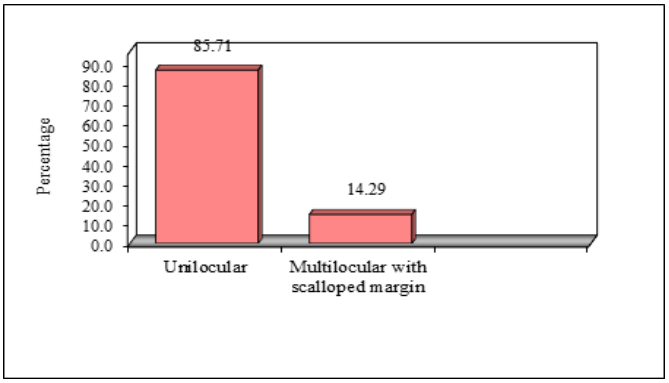
Most of the lesions occupied the posterior mandible, and 1 of the lesion was present in the anterior part of the mandible. The rest of the lesions extended from the anterior to the posterior area of the mandible, as shown in Graph 3.



Graph 3: Anatomical Location of the Lesion.

Radiological Assessment of the Lesion

Among 7 lesions, 6 were unilocular radiolucencies, and 1 was of multilocular and scalloped variety. This is depicted in Graph 4.



Graph 4: Radiological Features.

Postoperative Complications Assessment:

Complications such as infection, dehiscence, recurrence, sequestrum formation and sensory assessment were evaluated at the time intervals of 1 week, 1 month, 3 months, and 6 months. Out of 7 lesions, 1 showed paresthesia for up to 6 months and 1 lesion recurred after 6 months of surgery. No other complications were observed.

Discussion

Management of OKC is a topic of great debate over decades to the surgeons. Both aggressive and conservative techniques are used today. Researches over the years have shown that enucleation with chemical cauterization and peripheral ostectomy have yielded better results with minimal morbidity to the patients[15,16]. Carnoy's solution is a chemically cauterizing agent used to treat various cysts and tumors of aggressive nature in oral and maxillofacial surgery. In particular, carnoy's solution has been commonly used to treat OKC and unicystic ameloblastoma [17]. In 1886, Jean Baptiste Carnoy improved Clarke's (1851) fixation solution for botanic investigations, thereby proposing a mixture of absolute ethanol, chloroform, and glacial acetic acid in a 6:3:1 ratio, respectively. This solution is a fixation agent of rapid activity, useful for visualization of cell core, proteins, and glycogen but unsuitable for lipids. After almost half-century from this invention, the first use in surgery occurred by Zollinger and Moritz. Carnoy's solution with ferric chloride addition was assessed to enclose hemostatic features for the treatment. This combination provided moderate tissue penetration, rapid local fixation of surrounding cystic cells, and optimal hemostasis. In 1933, Cutler and Zollinger employed this solution for the clinical treatment of patients with cysts and fistulas. Voorsmit etal. Published the first report of the adjunctive usage of Carnoy's solution for surgical treatment of odontogenic keratocyst, which presented a high incidence of recurrence until that period. According to the authors, the application of Carnoy's solution is based on three aspects for such odontogenic lesions: Cyst epithelium is fragile, and its remnants might remain in the bone cavity; the occurrence of remaining microcysts or epithelium islands, which were on the walls of the initial cyst; and development of new keratocysts arising from derivations from the basal layer of oral epithelium. Therefore, Carnoy's solution warrants reduction of lesions, less fragility, improvement of complete enucleation, and adequate local hemostasis.

In the present study, we have assessed the outcomes of complications related to chemical cauterization treatment with carnoy's solution. In this study, the pre-operative parameters were: demographic features (age and sex of patients), clinical features, anatomical location of the lesion, and radiographic features. The postoperative complications assessed were: sequestrum formation, dehiscence formation, paresthesia, recurrences, and presence or absence of infection.

In our clinical study, we have selected 7 patients who were diagnosed histologically as OKC. The surgical modality considered was enucleation followed by chemical cauterization with carnoy's solution. Out of 7

patients, 2 were male (28.57%), and 5 were female (71.43%). The age ranged from 18 to 50 years, with a mean age of 20.00 years for male patients and 32.00 years for female patients. Most of the studies considered showed male predominance[4,15,16,18,19,20,21.] OKC occurs mostly in the second to third decade of life which was in accordance to other studies.[6,7,9,11,21]

In this study, all the patients presented with swelling. In 4 of the patients, the pain was present that was subsided before surgery through analgesics and antibiotics. In a review by Chirapathomsakul et al. (2006)[6], the most common clinical feature was swelling (12 out of 51 OKCs). In a retrospective review by Morgan et al. (2005)[19], the majority of the patients (23 of 40 patients) were symptomatic (pain, swelling, drainage, and infection), and the remaining were asymptomatic. In a review by Myoung et al. (2001)[22], 118 out of 256 patients had swelling at the first admission, and the remaining patients showed up pain pus discharge and paresthesia. Our study was consistent with the above reviews. According to Stoelinga (2000)[7], most cysts (34 out of 82 cysts) presented with signs of inflammation such as pain, swelling, and pus discharge. The swelling was the only symptom in 17 cases, and the rest were identified on routine dental radiographs.

This clinical study shows that most of the lesions were located in the posterior mandible (42.86%) involving the body of the mandible. Cysts in the mandible that were found between the 3rd molar and canine area are called body cysts. Cysts located between the canines are called symphyseal. In a study by Stoelinga (2001)[7], there was a striking predilection for the mandible, and in the mandible, most cysts were located in the 3rd molar area extending into ascending ramus. In a review by Chirapathomsakul et al. (2006)[6], the most common sites involved were the mandibular body, angle, and ramus regions. 46 lesions out of 67 were found in the mandible. In a study by Karaca et al. (2018)[4], 41% OKCs involved the posterior mandible. Leung et al. (2016)[21] showed that 75.2% of OKCs originated in the posterior mandible. Da Cunha et al. (2016)[20] in their analysis revealed that most of the lesions were located in the mandible (83.4%). Also, in a study by O Ribeiro junior et al. (2012)[9], 50% of the lesions were located in the posterior mandible (mandibular ramus region). In a systematic review by Diaz-Belenguer et al. (2016)[23], most OKCs appeared in the mandibular ramus and angle region. In a preliminary study on conservative treatment of OKCs by Mauretteet al. (2006)[24], most of the lesions occurred in the angle and ramus of the mandible (53.3%).

In this study, radiographically, most of the OKCs manifested as unilocular radiolucency (85.71%). In a review by Chirapathomsakul et al. (2006)[6], the main radiographic finding of 48 out of 67 OKCs (71.6%) was unilocular radiolucency. In a study by O Ribeiro Junior et al. (2012)[9], the significant radiographic pattern was unilocular radiolucency (77.3%). In a survey by Stoelinga (2001)[7], about half of the OKCs (40 out of 82 cysts) were of unilocular variety (48.8%). In a study by Voorsmit et al. (1981)[10], most OKCs were unilocular (67%). Our radiographic findings were consistent with the above studies.

We have assessed postoperative complications such as infection, sequestrum formation, dehiscence, paresthesia, and recurrence in a follow-up period of 1 week, 1 month, 3 months, and 6 months. The presence or absence of infection is generally observed in the immediate postoperative period up to 1 week. In our study, the postoperative infection was not observed in any of the cases. Sequestrum formation and dehiscence were not

observed in the present study. Sequestrum formation frequently occurs with cryotherapy due to deep bone necrosis and the possibility of accidentally freezing the periosteum in non-fenestrated areas.

We have observed a case of paresthesia post-operatively (14.29%). We have evaluated the impact of carnoy's solution on nerve damage. The recovery of sensory function was not achieved at the end of the follow-up period. The patient was recovered completely after a year of surgery. A 1-cm area of an intermediate portion of the lip skin just below the vermillion was chosen for evaluation. The methods used were static light touch, two-point discrimination, brush directional discrimination, and pin pressure. The degree of paraesthesia was assessed using a visual analog scale (VAS) ranging from 0 to 10 (0 = insensitive, 1-9 = paraesthesia and 10 = normal). The unaffected side was used as a control with an equivalent value of 10. Paraesthesia was subdivided into mild (7–9), moderate (4-6), and severe (1-3) based on the values of VAS[41]. Neuropathies secondary to direct application of carnoy's solution over the epineurium surface completely or partially resolve after days or months when solution use is limited to a single, 3-min application. Even in cases with a partial resolution, the residual dysfunction was considered absent or insignificant on the subjective evaluation and classified as light paresthesia during the clinical test. The neuropathies occurred in the exposure of the inferior alveolar nerve.

Recurrence was observed in a case at a follow-up period of 6 months (14.29%). The lesion was multilocular with scalloped margins occupying the molar and ascending ramus region. It recurred in the ascending ramus of the mandible after 6 months of enucleation and chemical cauterization with carnoy's solution. It was treated by enucleation followed by chemical cauterization with carnoy's solution through an extra oral approach. In this case, the recurrence was due to difficult access and incomplete removal of all cystic tissue. Recurrences tend to grow unnoticed by the patient. If patients are not called in at regular intervals, they grow to a considerable size and eventually give rise to inflammatory reactions.

The current data does not support the notion that most of the recurrences are seen in the first 5 years after surgery. It instead proves the point that when time elapses, more recurrences are found. It also establishes that comparing recurrence rates in different studies is meaningless because of the lack of thorough clinical follow-up of all patients and variable follow-up periods[7]. In a survey by Chirapathomsakul et al. (2006)[6], 1 case out of 11 cases (20%) recurred, treated by enucleation with carnoy's solution. According to them, recurrences were frequently found in the mandibular area associated with teeth. It is suggested that if enucleation is chosen as surgical treatment, the clinician should give more attention to the dentate area and remove the teeth if there is any doubt of leaving pathologic tissue behind. In a retrospective review by Morgan et al. (2005)[19], out of 40 cases, only 2 were treated by enucleation and carnoy's solution. 1 case recurred among the 2 cases. According to them, recurrences were observed in patients with long follow-up periods. They concluded that the possibility of having more recurrences because of a longer follow-up. In a retrospective study by Leung et al. (2016)[21], the recurrence rate of 11.4% for OKCs treated by enucleation and application of carnoy's solution was observed. They have recommended that OKCs treated with enucleation and application of carnoy's solution at increased risk of recurrence should be reviewed at 6 monthly intervals.

The limitations of this study were small sample size and short follow-up period. Further studies with ample sample size and a long follow-up period are necessary to find the outcome of enucleation with the application of carnoy's solution.

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