Review Article

The Changing Landscape in Treatment of Cystic Lesions of the Jaws

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ABSTRACT

Objective: Cystic lesions of the jaw are common pathologies of chronic swelling of the jaw in oral and maxillofacial regions. Different treatment modalities have been described in the literature. However, the existence and proper treatment of these cysts remains a contentious topic. The aims of this review were to discuss the complexity of various surgical treatment and as factors with potential to influence outcome treatment. Finally, a practical and a rational clinical guideline for the management of such lesions have been suggested. **Materials and Methods:** A literature search without language limitation was performed in 2018 using MEDLINE, PubMed, Scopus, and Embase. Keywords for the search included the following terms: jaws cyst, cystic lesions, odontogenic cysts, cystic tumors, pseudocysts, treatments, therapy, wound healing, bone regeneration, and teeth involved cysts. Prospective or retrospective clinical studies with a sample size of $n \geq 5$ were evaluated and included in this review. The exclusion criteria were studies with unclear reporting of the treatment applied or outcome, nonhuman studies, case reports, letters, preface, comments, and cystic lesions associated to syndrome. After the full reading, 30 articles were included in the quantitative synthesis for the review. No meta-analysis could be performed due to the heterogeneity of the studies included. Clinical radiographic images were presented to illustrate the principles of some surgical treatments. **Conclusion:** Conservative surgery with primary closure defect (less than 4 cm) remains an initial approach, which reduces the morbidity of aggressive surgeries and obtains the complete bone healing before 24 months of postoperative. Marsupialization is considered as the most common option for the treatment of large cystic lesions when cases are carefully selected. Evocyst is an attractive new technique of obtaining complete bone defect healing within <3 months.

KEYWORDS: *Bone regeneration, surgical methods, teeth involved cystic lesions*

INTRODUCTION

A cyst of the jaws is a pathological cavity that contains fluid, semifluid, or gas, which is either completely or partially covered by epithelial tissue, and is not caused by the accumulation of pus.[1] Cystic lesions of the jaws include pseudocysts (aneurysmal bone cyst and simple bone cyst) or cystic tumors (calcifying odontogenic cyst, glandular odontogenic cyst, or unicystic ameloblastoma), which may present similar clinical and radiographic appearances. Some of them (odontogenic keratocyst [OKC], calcifying odontogenic cyst, glandular odontogenic cyst, unicystic ameloblastoma, and botryoid cyst) show highly aggressive behavior and a tendency to recur.[2,3] The surgical treatment of cystic lesions of the jaws is a significant proportion of the workload of oral and maxillofacial surgeons that relies on good preoperative evaluation.[4] Eradication

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of the lesions remains the goal of any treatment that must be achieved for ensuring prevention of recurrence and minimum morbidity.[5] Enucleation or curettage is the most commonly used surgical treatment methods whenever possible. The outcome for the small lesions is usually satisfactory after simple operation, whereas the patients with large lesions present some limitations such as the risk of the pathologic fracture and a higher incidence of relapse.[6-8] Radical resection techniques may be performed for large and aggressive cysts. Nevertheless, this approach has not gained much popularity due to high morbidity that leaves greater tissue destruction with facial disfigurement, occlusion disorder, a decreased masticatory function, and poor quality of life after surgery.

In this review, we summarized the various surgical treatment modalities in the retrieved articles performed for cystic lesions of the jaws and suggested the rational treatment approach.

Materials and Methods

A review of the literature was performed in 2018 using MEDLINE, PubMed, and Scopus. Search keywords included the following terms: jaws cyst, cystic lesions, odontogenic cysts, cystic tumors, pseudocysts, treatments, therapy, wound healing, bone regeneration, graft, teeth involved cysts, and quality of life. Reference lists of all articles retrieved from those databases search were selected for further relevant studies. Abstracts were reviewed and relevant articles were given more attention, and if possible, reviewed in full. Prospective or retrospective clinical studies, with a sample size of $n \geq 5$, in which the main focus was on data regarding treatment methods, bone regeneration, teeth involved in the cyst's lumen, and all factors with potential to influence outcome were evaluated and included in this review. The exclusion criteria were studies with unclear reporting of the treatment applied or outcome, nonhuman studies, case reports, letters, preface, comments, and cystic lesions associated to syndrome. Two authors chose the articles simultaneously, following the inclusion criteria, first, by reading of titles and abstracts of the found bibliographic cites to identify the most relevant studies and then, by means of reading the full text. After the full reading, 30 articles were included in the quantitative synthesis for the review. The flow chart of the selected articles[5–7, 9-35] can be seen in Figure 1. No meta-analysis could be carried out due to the heterogeneity of the studies included. Clinical radiographic images were presented to show the principles of some surgical treatments.

Treatment

Enucleation or curettage

Enucleation, also called the Partsch II operation or cystectomy, is a surgical technique, which requires the complete removal of the cyst sac and healing of the wound by primary intention. The lesion is separated from the bone without bone removal along a tissue plane between the connective tissue envelope and the surrounding bone.[8] The only bone that is removed is that which is required for surgical access. Curettage is a method in which the wall of the cyst cavity is surgically scraped and its contents removed. The lesion is thus removed from the bone and an inexact, immeasurable, variable amount of surrounding bone is also removed.[36,37] As cystic lesions are slow growing, the bone cavity is surrounded by a smooth cortication, and complete enucleation will show a cavity in the bone devoid of any soft tissue lining. However, when the cyst lining becomes friable because of secondary infection or in case of an OKC in which the nature of the cyst is infiltrative, the cavity may not appear smooth after enucleation and need further curettage.[38] Healing of the cystic defect after enucleation, with or without the use of bone grafts, has been studied. However, so far there is no clear recommendation for specific options to fill the cavities with autologous bone or bone substitute material. In the literature, different bone substitute materials have been described.[9,10] Despite the results of these investigations, there is a paucity of evidence to support one or the other treatment as well as what kind of filling materials should be used.

Enucleation with adjunctive therapy

As a result of the difficulty in enucleating thin friable wall cysts in one piece and to reduce the chances of recurrence or eliminate the possible vital cells left behind in the defect, enucleation followed by superficial cauterizing agent may be the preferred treatment approach for some aggressive cystic lesions or cystic tumors.[2] Careful follow-up is needed as the chances of recurrence are around 30%–40% for these lesions. Cysts associated with crowns/unerupted tooth/teeth in the ascending ramus and in the tuberosity areas of the maxilla should be enucleated with the attached overlying mucosa.[11] This may eliminate newly developing cysts from epithelial islands or microcysts, which are found in approximately 50% of the cases. In addition, a study on 486 cysts of the jaws cited by Stoelinga[39] did not find any ordinary cyst in the lower third molar ascending ramus area. The authors suggested treating these lesions as potentially aggressive cysts. Sharif *et al.*[40] compared enucleation of OKC alone versus enucleation and adjunctive treatment with a Carnoy's

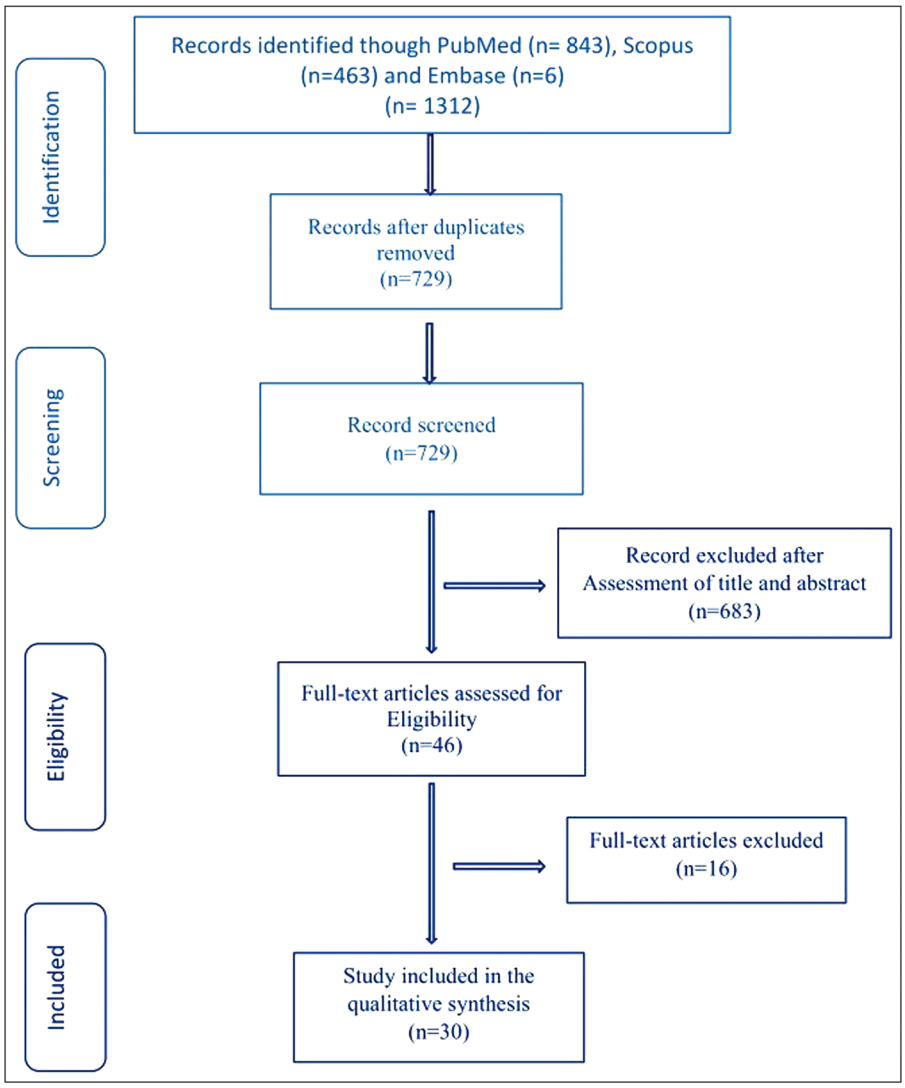

Figure 1: Flow of articles through the review according to the PRISMA statement

solution and found benefit in the use of adjunctive treatment. However, even after using Carnoy's solution, microcysts and epithelial islands were always seen in the overlying attached mucosa of OKC and so recurrence took place. The authors described the use of electrocauterization in the areas where the cyst had contact with soft tissues.[12] Liquid nitrogen has the ability to devitalize bone *in situ* while leaving the inorganic framework untouched; as a result of this, cryotherapy has been used alternatively for a number of locally aggressive jaw cysts.[13] Cryotherapy and Carnoy's solution given around the inferior alveolar nerve left patients with postoperative paresthesia of the lower lip. The merits of enucleation are the possible primary closure of the wound, reduction of postoperative care, and examination of the whole cystic lining.

Marsupialization or conventional decompression

The terms decompression and marsupialization are used in many reports as synonyms. Decompression implies any means taken to create an orifice in the cyst with the smallest possible opening to reduce the pressure within the cystic lesion and with placement of tubing to maintain the drainage. This means that decompression encompasses marsupialization and is defined as any method used to relieve intracystic pressure by keeping a patent opening to the exterior, which could be the mouth, nose, or maxillary sinus. However, on the contrary, marsupialization is a means of decompressing a cyst, in its true sense, the conversion of the cyst into a pouch of the mouth by suturing the cyst wall to the oral mucosa. This implies the creation of a sizable opening or communication.[14,41] Marsupialization and decompression are very similar surgical procedures aimed at decreasing cystic size by reducing the pressure of the cystic fluid and inducing bony apposition to cystic walls. Today, cystostomy is known as Partsch I or marsupialization. Here, the cavity is packed with different gauzes soaked with antiseptic solution or

tubes until the line of junction between the cyst lining and the oral mucosa has healed. Obturator (acrylic resin and polymethyl methacrylate) or others materials (resin plug, plastic button with a hole, and acrylic stent) are fabricated and placed 1 week later, and the size is gradually reduced by trimming as the cyst heals.[15,16,42] A second procedure (enucleation) is often carried out to eliminate the residual lesions 3–6 months later.[17,18] Decompression can be used alone or combined with or without tooth extraction, curettage, or other surgical treatment modalities.[43] The technique is becoming more popular and is the most common option used for large lesions, dependent on several factors.[19] It is most often used in the four common cystic lesions including dentigerous cysts, OKC, radicular cysts, and unicystic ameloblastoma.[44] The merit of this procedure is to minimize the risk of damage to vital structures, to prevent pathological fractures, to stimulate osteogenesis, to promote the eruption of the involved teeth, and to maintain pulp vitality. The procedure is also useful in young or older patients who are medically compromised.[20,21] In contrast, disadvantages include a second surgical procedure and a long postoperative care.

After Partsch I treatment of the cysts, the bone regenerates with the diminishing cyst cavity if the surgical opening was maintained, otherwise, this approach can fail. The maintenance of the surgical opening is a critical determinant for the success of marsupialization. Several methods for maintaining the patency of the surgical opening, including iodoform gauze packing, stents, and obturator prostheses, have been used.[22,45] Gauze used to maintain the open cavity is less hygienic and requires frequent replacement, which can reduce the quality of life of patients. Application of obturators after marsupialization has various clinical advantages, including fewer visits to the clinic to replace absorbent gauze, preclusion of food entry into the lesion, and improved hygiene in the area. Various factors are associated with the required duration of the obturator, including age, number of remaining teeth, type of primary disease, sites of the lesion, the pattern of missing teeth, the type of obturator prosthesis, and dates of insertion. There are limited studies on the design or evaluation of survival rate of all types of the obturator and the factors that expedite their removal. In these reports, it is usually seen that the tube needs irrigation twice a day, the obturator needs shrinking every recall time, and gauze needs changing every week. The objectives remain the same: minimize the cyst size, preserve the vital tissues, and promote osteogenesis.

Recently, the evacuator for odontogenic cysts (Evocyst), which is a closed and active (vacuum-like) drain system to treat odontogenic cysts by means of active intracystic negative pressure to promote osteogenesis, has been reported.[46] Interestingly, this device reveals a high rate of a new bone formation that take place within <3 months [Figure 2], which is quite remarkable when compared to conventional tubes used for conventional decompression that are passive drains requiring up to 12 months to heal [Figure 3]. In addition to the advantages of the conventional decompression technique, the new approach presents other advantages including the increased vascularity with concomitant enhanced bone formation around the cyst and mostly more rapid recovery. Therefore, the approach appears to be a variable choice.[47] However, several follow-up visits, uncomfortable intraoral unit, and challenge to keep oral hygiene [Figure 4] are the disadvantages of this technique.

Management of tooth/teeth involved in the cystic lesions

To extract or preserve the teeth involved in the cyst remains a dilemma usually encountered by surgeons. Extraction of supernumerary teeth, impacted teeth, teeth without function, and those of recurrent cases are, no doubt, one of the necessary measures. However, in other situations, the treatment of involved teeth remains undefined. To reduce the relapse of cystic lesions, some authors recommend extraction of involved teeth after curettage,[23,48,49] whereas Varinauskas *et al.*[24] argued that relapse was associated with the presence of the residual cystic wall or multicystic settings rather than the maintenance of the involved teeth. Zhao *et al.*[25] found three recurrences in a review of 19 recurrent OKCs. The authors speculated this may be due to incomplete removal of the epithelium around the tooth roots, which extended into the cyst cavity. They recommended the removal of the involved teeth or treatment by apicoectomy if the roots extended into the cyst lumen or interfered with the complete removal of the cyst wall. On the contrary, to preserve the patients' masticatory function after surgery, Tan *et al.*[26] suggested teeth could be preserved with less risk to adjacent vital structures when marsupialization was performed in combination with secondary enucleation. To date, studies evaluating the management of teeth involved within cystic lesions are few, and the available literature is challenging, therefore the issue needs to be investigated further.

Bone healing and radiographic appearances

Enucleation of cystic lesions with safe closure of the wound has been the standard procedure to the present day,[18,27,28] and numerous studies have evaluated the bone healing. Ihan *et al.*,[28] in a large mandibular bone defects for 33 patients, revealed a mean gain of bone density of

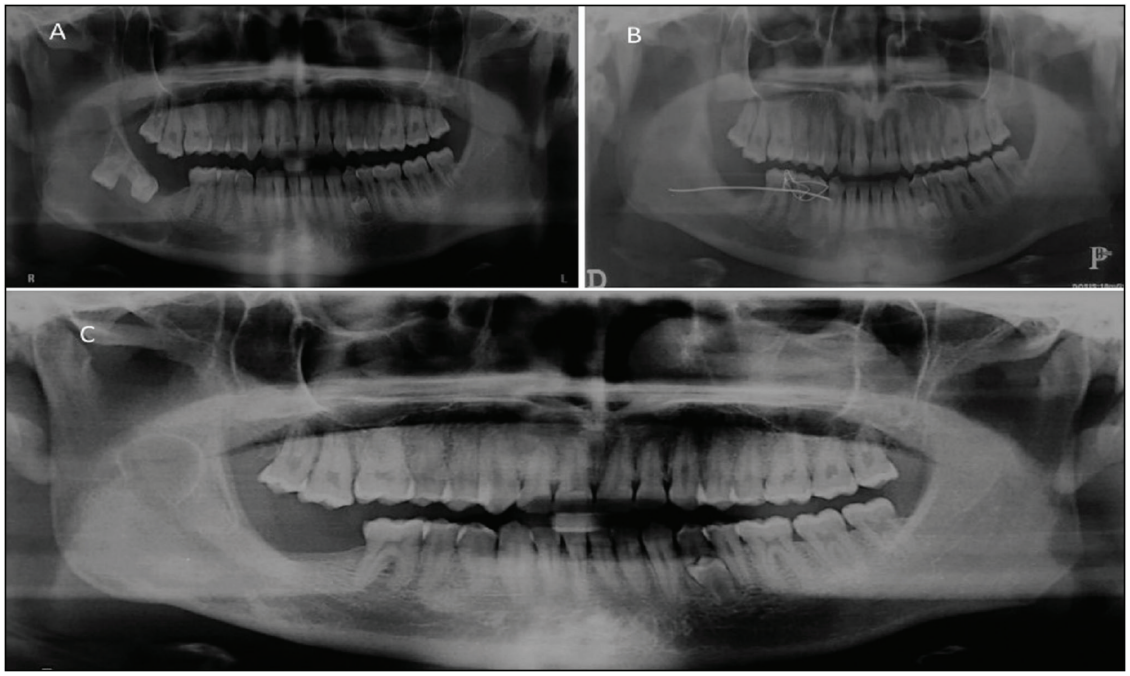

Figure 2: (A) A 17-year-old male patient presented to the clinic with a large radiolucent area including the right mandibular ramus, angle, and part of the body. The lower right second and third molars were involved in the lesion. The histopathological diagnosis was an odontogenic keratocyst. Active decompression/distraction sugosteogenesis (AD/DS) was initiated. (B) One month after AD/DS, the entire lesion has disappeared. The radiographic appearance is of woven, newly formed bone. (C) A 2-year follow-up image demonstrate consolidation of bone. From Drs. Pedro Rodríguez and Jaime Castro-Núñez with permission

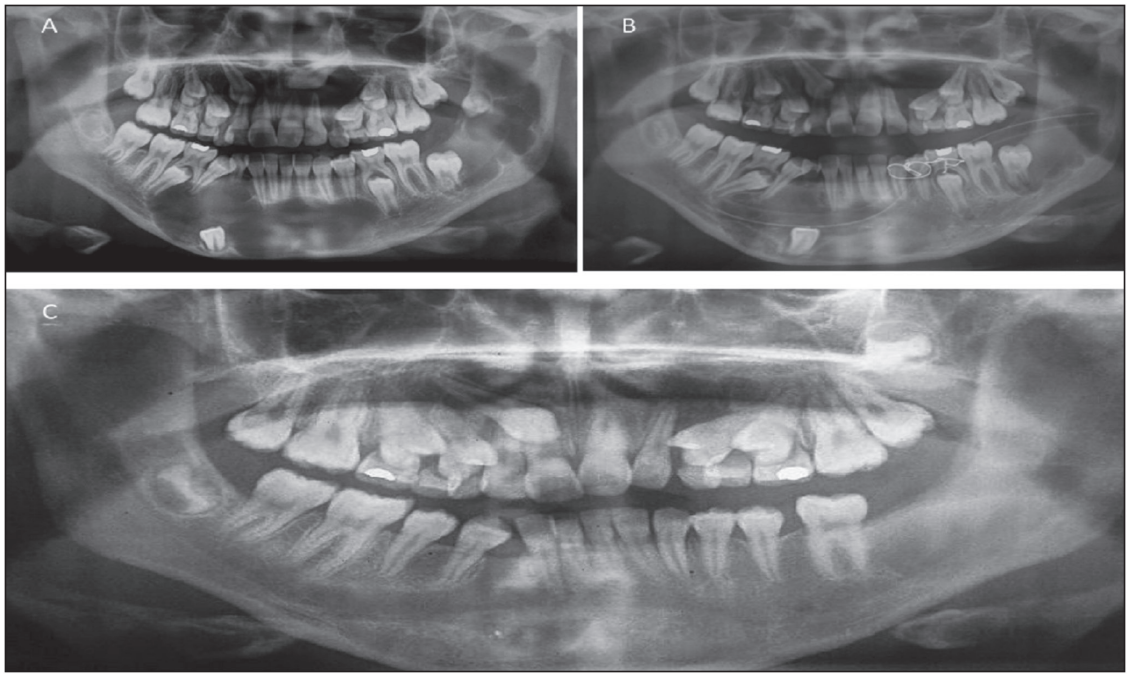

Figure 3: (A). Decompression. A female patient presents with an enormous odontogenic keratocyst. She is treated using two decompression tubes (double decompression). (B) Four months after initiating decompression technique, the lesion starts to reduce with newly formed bone. (C) After 12 months of decompression, the lesion is no longer visible. From Drs. Pedro Rodríguez and Jaime Castro-Núñez with permission

7%, 27%, and 46% after 2, 6, and 12 months, respectively. But in smaller defects measuring 2–3 cm of size, the authors observed a final bone density of 97% after 12 months, as was found by Yim and Lee.[50] However, the evaluation of spontaneous bone after enucleation of 27 cysts larger than 4 cm, the radiographic analysis

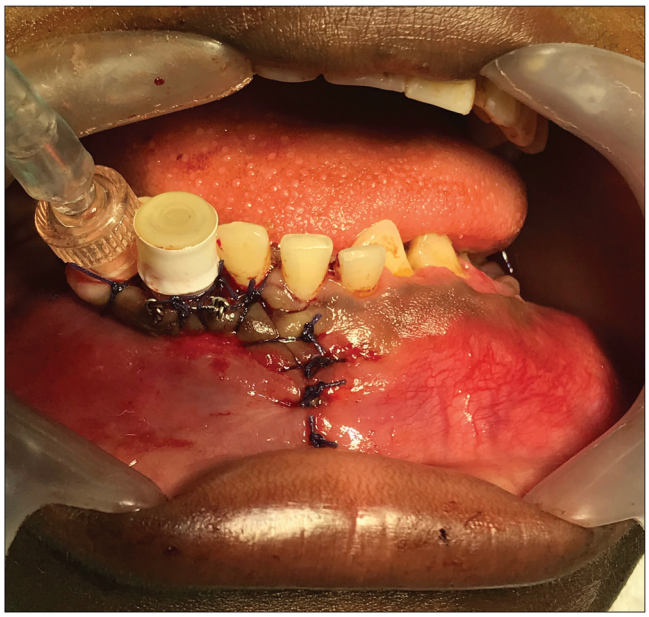

Figure 4: Active decompression (AD) and distraction sugosteogenesis (DS) initiated using the Evocyst. The picture shows the intraoral unit in place: irrigation port and decompression tube; the latter being attached to the extraoral unit. From Drs. Pedro Rodríguez and Jaime Castro-Núñez with permission

revealed an increased bone density of 37.0%, 48.2%, and 91.0% after 6, 12, and 24 months, respectively.[27,28] The authors postulated that the minimal diameter of the lesion is the fundamental parameter influencing better bone healing. In contrast, this affirmation was opposite to the recent report of 53 cysts treated by decompression in which the cyst's diameter was not found to have an influence on the effectiveness of the decompression.[29] Preservation of the periosteum and bone wall, which have a large capacity for spontaneous ossification and bone repair, is the most significant criteria for normal bone healing. Bone healing also depends on an adequate blood supply, a solid basis for bone deposition, and immobilization.[51] Cystic lesions located in the mandible present an ideal bone defect (solid bone) after enucleation compared to maxilla lesions. This make easy a stable blood clot leading to safe healing process. Spontaneous bone regeneration can be delayed in older patients with bicortical, circular defects of the anterior maxilla.[28,50] For Partsch, cystectomy should be constrained to smaller defects up to 2 cm and when applied to larger cysts, could possibly lead to infections. However, primary mucoperiosteal closure of the defects on solid margins with simultaneous antibiotic treatment attains a complication rate of fewer than 5%, even in the defects measuring more than 3 cm in diameter.[27,28]

In addition, Various studies have also reported high success rates of ossification in defects after decompression. Anavi *et al.*[30] obtained a good performance in 60% of ossification defects in 57 cysts, moderate performance in 29%, and poor performance in 11% after a mean decompression time of 9.2 ± 5.2 months. Zhao *et al.*[31] found significant bone formation (55%) in the affected sites, 3 months postoperatively, as was found by Oliveros-López *et al.*[20] No difference was found in the reduced rate of jaw cysts depending on gender,[20,31] in contrast to age. Older patients had smaller reductions of cystic lesions than younger ones. This affirmation was consistent with the recent report of Lee *et al.*,[21] in which the decrease size reduction was greater in patients in their teens or their twenties compared to that in the other age groups even though the reduction rates were not significantly different. The difference in bone density values was calculated between the cyst area and healthy bone in more than two postoperative follow-up visits. However, other authors measured cyst volume in pre- and post-decompression imaging, and the graded scale on the basis of the formula by Nakamura *et al.*[19] is also taken as the size of cyst volume. Traditionally, 6–12 months after marsupialization is considered as the period in which bone formation has sufficiently occurred and when enucleation may be performed.

The radiographic appearance of new bone formation shows as ground glass or radial bone spicules in the periphery of cystic lesions or the original bone cavity.[18,32] However, in recurrent cystic lesions and especially recurrent OKCs, imaging is affected by the postoperative time interval and location.[25] Recurrent lesions appeared as radiolucency areas without a markedly sclerotic margin within 1 year postoperatively. Those occurring after a longer postoperative time had a radiolucent appearance with a clear sclerotic border of the bone. With regard to the location, radiolucency in the maxilla presents with no significant sclerotic border, owing to the thinness of bone and image superimposition on plain radiographs.

Resection and reconstruction defects

Resection of the cystic lesions of jaws remains a challenge for surgeons. This approach, including partial resection or total resection (maxillectomy and mandibulectomy) could be justified in some cases, such as cystic lesions with multiple recurrences, large multilocular cysts with severely thinned out bone or multiple perforations, cases of malignancy transformation within the cysts, and patients with poor compliance to follow-up appointments.[33,52] Radical resection has undoubtedly shown the lowest recurrence as compared to a series of conservative measures.[53,54] However, morbidity associated with resections, which usually necessitates

reconstructive surgery, has been a deterrent in adopting this treatment modality for benign lesions. The quality of life seems to be poor, and reconstruction of the defect should restore the continuity of defects and restoration of functions. There are many options for the reconstruction of the defects.[55] It perhaps appears that oromaxillary function was not an important matter in the previous treatment of cystic lesions. However, the fact is that radical resection is used in the treatment of these lesions, as well as enucleation, and both are not without repercussions. A study from Tan *et al.*,[26] comparing tooth loss after three types of treatment of mandibular OKC (enucleation, segmental mandibulectomy, and marsupialization) and posttreatment masticatory performance with and without a removable partial prosthesis, found that the preservation and/or restoration of posterior functional teeth was important to maintain and to improve the masticatory function in those patients. Augustin *et al.*[56] randomly assigned patients into two groups; one group received a removable acrylic denture (n = 189) and the other group did not (n = 189). They found that the patients in the denture group, having at least two functional units, had better masticatory performance than the non-denture group.[56] Given above, evaluation of the oral and maxillary function of the patients that had undergone either radical surgery or enucleation with the extraction of the teeth is necessary.

A RATIONAL APPROACH TREATMENT

On the basis of previous publications,[3,34,57,58] a rational approach for the management of cystic lesions of the jaw was suggested and summarized in Figure 5. The cystic lesions having a size <5cm can be managed with simple enucleation/curettage. In the few cases that had a clinical or radiographic evidence of multilocular lesions, extensive lesions with involvement of adjacent soft tissues or history of multiples recurrent lesions,

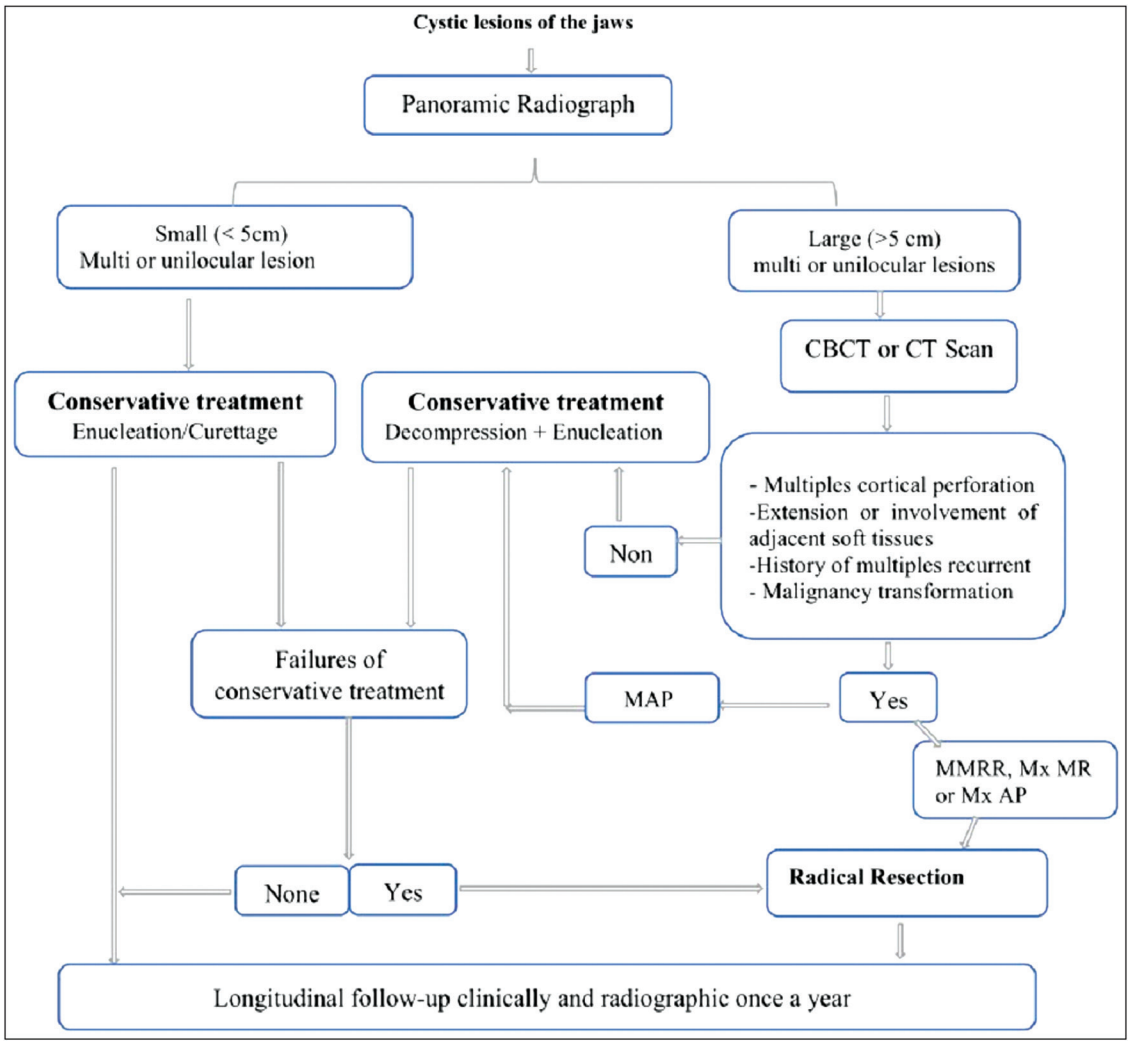

Figure 5: Algorithm managing cystic lesions of the jaws. MMRR = mandibular molar-ramus region, Mx MR = maxilla molar region, MAP = mandibular anterior-premolar, Mx AP = maxilla anterior-premolar, CBCT = Cone Beam Computed Tomography, CT = Computed tomography

mostly for unicystic ameloblastoma, OKCs, glandular odontogenic cyst, botryoid cyst, and especially located in the mandibular molar-ramus or maxilla molar areas should be considered to have an aggressive behavior, and radical resection could be the first choice of treatment option dependent on the surgeon's training, available resources, and the patient's preferences. Otherwise, conservative treatment methods such as decompression with a second surgical procedure (enucleation), and other aggressive approach than bone resection can be chose; and the failures of these treatment must indicate the radical resection method as well as for extensive lesions without aggressive behaviors. Longitudinal follow-up should be considered. Among cystic lesions of jaws, OKC and unicystic ameloblastoma are the most common and aggressive lesion is with high recurrence rate (RR). A recent review of 2287 cases of OKC aimed to find the best surgical treatment with the lowest risk of recurrence (RR) found that enucleation alone had an RR of 23.1%, enucleation with curettage had an RR of 17.4%, enucleation and Carnoy's solution had 11.5%, enucleation plus liquid nitrogen cryotherapy 14.5%, marsupialization alone had an RR of 32.3%, decompression followed by the second stage had an RR of 14.6%, and 8.4% was see in resection.[35]

Conclusion

Conservative surgery remains an initial approach that reduces the morbidity of aggressive surgeries and preserves the anatomical structure. Complete bone healing for defects less than 4 cm in diameter is fast obtained before 24 months postoperatively. Preservation of the periosteum and bone wall, which have a large capacity for spontaneous ossification and bone repair associated to adequate blood supply, a solid basis for bone deposition, and immobilization are the most significant criteria for normal bone healing. Marsupialization should be considered as the most common option for the treatment of large cysts when cases are carefully selected. Evocyst, when available to the surgeon, is definitely an attractive new technique of obtaining complete bone defect healing within <3 months. However, oral and maxillofacial surgeons must make the best selection of the appropriate treatment modality based on various factors, including the age, location, extent of the lesion, presence of cortical perforation, and history of recurrent lesions.

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Conflicts of interest

There are no conflicts of interest.

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