Review Article

The Changing Landscape in Treatment of Cystic Lesions of the Jaws

Bushabu Fidele Nyimi¹,², Yifang Zhao¹, Bing Liu¹

¹Department of Oral Maxillofacial Head and Neck Oncology Surgery, The State Key Laboratory Breeding Base of Basic Science of Stomatology and Key Laboratory of Oral Biomedicine Ministry of Education, School and Hospital of Stomatology, Wuhan University, Wuhan, China, People’s Republic of China, ²Oral and Maxillo-Facial Surgery, Teaching Hospital of Kinshasa University, University of Kinshasa, Kinshasa, Democratic Republic of the Congo

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

Address for correspondence: Dr. Bushabu Fidele Nyimi, The State Key Laboratory Breeding Base of Basic Science of Stomatology and Key Laboratory of Oral Biomedicine Ministry of Education, School and Hospital of Stomatology, Wuhan University, 237 Luoyu Road, Wuhan, Hubei 430079, P.R. China. E-mail: fidelenyimi@yahoo.fr

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Nyimi BF, Zhao Y, Liu B. The Changing landscape in treatment of cystic lesions of the jaws. J Int Soc Prevent Community Dent 2019;9:328-37.
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 ≥ 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.[9] 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 chart of the selected articles.

**Table 1:** Summary of the selected articles.
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.

MARSUPLIALIZATION 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
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. 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. 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, whereas Varinauskas et al. 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. 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. 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, and numerous studies have evaluated the bone healing. Ihan et al. in a large mandibular bone defects for 33 patients, revealed a mean gain of bone density of...
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. However, the evaluation of spontaneous bone after enucleation of 27 cysts larger than 4 cm, the radiographic analysis

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 Rodriguez and Jaime Castro-Núñez with permission.
Nyimi, et al.: Cystic lesions of the jaws

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.\[10\] 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.\[13\] found significant bone formation (55%) in the affected sites, 3 months postoperatively, as was found by Oliveros-López et al.\[16\] 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 (maxillecotomy 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. 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., 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., 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. 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, 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 <5 cm 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](image-url)
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.[69]

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 4cm in diameter is fast obtained before 24 months postoperatively. Preservation of the peristeme 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.

ACKNOWLEDGEMENT
We are thank full to professor Castro-Núñez J from Monteria, Colombia University/USA who helped us with those best radiographic images, and critically reviewed this manuscript.

FINANCIAL SUPPORT AND SPONSORSHIP
Nil.

CONFLICTS OF INTEREST
There are no conflicts of interest.

REFERENCES
1. Kramer IR. Changing views on oral disease. Proc R Soc Med 1974;67:271-6.
2. Buchbender M, Neukam FW, Lutz R, Schmitt CM. Treatment of enucleated odontogenic jaw cysts: A systematic review. Oral Surg Oral Med Oral Pathol Oral Radiol 2018;125:399-406.
3. Shah AA, Sangle A, Bussarsi S, Koshy AV. Glandular odontogenic cyst: A diagnostic dilemma. Indian J Dent 2016;7:38-43.
4. Morgan PR. Cysts and cystic lesions of the jaws. Curr Diagn Pathol 1995;2:86-93.
5. Kolokythas A, Fernandes RP, Pazoki A, Ord RA. Odontogenic keratocyst: To decompress or not to decompress? A comparative study of decompression and enucleation versus resection/ peripheral ostectomy. J Oral Maxillofac Surg 2007;65:640-4.
6. Myoung H, Hong SP, Hong SD, Lee JI, Lim CY, Choung PH, et al. Odontogenic keratocyst: Review of 256 cases for recurrence and clinicopathologic parameters. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001;91:328-33.
7. Manor E, Kachko L, Puterman MB, Szabo G, Bodner L. Cystic lesions of the jaws—A clinicopathological study of 322 cases and review of the literature. Int J Med Sci 2012;9:20-6.
8. Pogrel MA. Treatment of keratocysts: The case for decompression and marsupialization. J Oral Maxillofac Surg 2005;63:1667-73.
9. Lee H, Lee SJ, Seo BM. Investigation of postoperative complications of intrabony cystic lesions in oral and maxillofacial region. J Oral Maxillofac Surg 2019;71:1-9. In press.
10. Pradel W, Eckelt U, Lauer G. Bone regeneration after enucleation of mandibular cysts: Comparing autogenous grafts from tissue-engineered bone and iliac bone. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101:285-90.
11. Gosau M, Draenert FG, Müller S, Frerich B, Bürgers R, Reichert TE, et al. Two modifications in the treatment of keratocystic odontogenic tumors (KCOT) and the use of Carnoy’s solution (CS)—A retrospective study lasting between 2 and 10 years. Clin Oral Investig 2010;14:27-34.
12. Stoelinga PJ. The treatment of odontogenic keratocysts by excision of the overlying, attached mucosa, enucleation, and treatment of the bony defect with Carnoy solution. J Oral Maxillofac Surg 2005;63:1662-6.
13. Schmidt BL, Pogrel MA. The use of enucleation and liquid nitrogen cryotherapy in the management of odontogenic keratocysts. J Oral Maxillofac Surg 2001;59:720-5; discussion 726-7.
14. Pogrel MA, Jordan RC. Marsupialization as a definitive treatment for the odontogenic keratocyst. J Oral Maxillofac Surg 2004;62:651-5; discussion 655-6.
15. Huang YJ, Lai ST, Chen CH, Chen CM, Wu CW, Shen YH. Surgical management of ameloblastoma in children. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;104:478-85.
16. Zhao YF, Wei JX, Wang SP. Treatment of odontogenic keratocysts: A follow-up of 255 Chinese patients. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;94:151-6.
17. Ji-Su O, Jae-Seek Y, Su-Gwan K. Clinical and histomorphometric evaluation of decompression followed by enucleation in the treatment of odontogenic keratocyst. J Dent Sci 2018;13:329-33.

18. Bodner L, Bar-Ziv J. Characteristics of bone formation following marsupialization of jaw cysts. Dentomaxillofac Radiol 1998;27:166-71.

19. Nakamura N, Mitsuyasu T, Mitsuyasu Y, Taketomi T, Higuchi Y, Ohishi M. Marsupialization for odontogenic keratocysts: Long-term follow-up analysis of the effects and changes in growth characteristics. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;94:543-53.

20. Oliveros-López L, Fernández-Olavarrieta A, Torres-Lagares D, Serrera-Figallo MA, Castillo-Oyagie R, Segura-Egen JJ, et al. Reduction rate by decompression as a treatment of odontogenic cysts. Med Oral Patol Oral Cir Bucal 2017;22:e643-50.

21. Lee ST, Kim SG, Moon SY, Oh JS, You JS, Kim JS. The effect of decompression as treatment of the cysts in the jaws: retrospective analysis. J Korean Assoc Maxillofac Surg 2017;43:83-7.

22. Murakami M, Nishi Y, Nishio M, Minemoto Y, Shimizu T, Nishimura M. A retrospective cohort study of the cumulative survival rate of obturator prostheses for marsupialization. J Prosthodont 2017;01:1-6.

23. Chirapatthomskul D, Sastravaha P, Jansisyanont P. A review of odontogenic keratocysts and the behavior of recurrences. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101:5-9; discussion 10.

24. Varinauskas V, Gervickas A, Kavoliūniene A. Analysis of odontogenic cysts of the jaws. Medicina (Kaunas) 2006;42:201-7.

25. Zhao Y, Liu B, Cheng G, Wang SP, Wang YN. Recurrent keratocystic odontogenic tumours: Report of 19 cases. Dentomaxillofac Radiol 2012;41:96-102.

26. Tan ZZ, Liu B, Wei JX, Zou H, Zhao YF. Effects of mandibular odontogenic keratocyst surgery and removable partial prostheses on masticatory performance. J Prosthet Dent 2007;97:107-11.

27. Chiapasco M, Rossi A, Motta JJ, Crescentini M, James J. Spontaneous bone regeneration after enucleation of large mandibular cysts: A radiographic computed analysis of 27 consecutive cases. J Oral Maxillofac Surg 2000;58:942-8; discussion 949.

28. Ihan Hren N, Miljacic M. Spontaneous bone healing of the large bone defects in the mandible. Int J Oral Maxillofac Surg 2008;37:1111-6.

29. Marin S, Kirnbauer B, Rugani P, Mellacher P, Mayer M, Jakse N. The effectiveness of decompression as initial treatment for jaw cysts: A 10-year retrospective study. Med Oral Patol Oral Cir Bucal 2019;24:e47-e52.

30. Anavi Y, Gal G, Miron H, Calderon S, Alon DM. Decompression of odontogenic cystic lesions: Clinical long-term study of 73 cases. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;12:164-9.

31. Zhao Y, Liu B, Han QB, Wang SP, Wang YN. Changes in bone density and cyst volume after marsupialization of mandibular odontogenic keratocysts (keratocystic odontogenic tumors). J Oral Maxillofac Surg 2011;69:1361-6.

32. Kawai T, Murakami S, Hiranuma H, Sakuda M. Healing after removal of benign cysts and tumors of the jaws. A radiologic appraisal. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1995;79:517-25.

33. Blanas N, Freund B, Schwartz M, Furst IM. Systematic review of the treatment and prognosis of the odontogenic keratocyst. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;90:553-8.

34. Singh M, Shah A, Bhattacharya A, Raman R, Ranganatha N, Prakash P. Treatment algorithm for ameloblastoma. Case Rep Dent 2014;2014:121032.

35. Al-Moraisi EA, Dahan AA, Alwadeei MS, Oginni FO, Al-Jamali IM, Alkhatari AS, et al. What surgical treatment has the lowest recurrence rate following the management of keratocystic odontogenic tumor?: A large systematic review and meta-analysis. J Craniofaciof Surg 2017;45:131-44.

36. Peterson LJ. Let’s say what we cut. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1993;76:1.

37. Gardner DG, Pecak AM. The treatment of ameloblastoma based on pathologic and anatomic principles. Cancer 1980;46:2514-9.

38. Rajiv M.B. Textbook of Oral and Maxillofacial Surgery. 1st ed. New Delhi, India: Jaypee Brothers Medical Publishers; 2014.

39. Stoelting JA. The management of aggressive cysts of the jaws. J Maxillofac Oral Surg 2012;11:2-12.

40. Sharif FNJ, Oliver R, Sweet C, Sharif MO. Interventions for the treatment of keratocystic odontogenic tumors. Cochrane Database Syst Rev 2010;8:CD008464.

41. Castro-Núñez J. Decompression of odontogenic cystic lesions: Past, present, and future. J Oral Maxillofac Surg 2016;74:104.e1-e9.

42. Lux HC, Goetz F, Hellwig E. Case report: Endodontic and surgical treatment of an upper central incisor with external root resorption and radicular cyst following a traumatic tooth avulsion. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;110:e61-7.

43. Balaji TS. Management of infected radicular cyst by surgical decompression. J Conserv Dent 2010;13:159-61.

44. Hou R, Zhou H. Articles of marsupialization and decompression on cystic lesions of the jaws: A literature review. J Oral Maxillofac Surg Med Patol 2013;25:299-304.

45. Sakkas N, Schoen R, Schulze D, Otten JE, Schmelzeisen R. Obturator after marsupialization of a recurrence of a radicular cyst of the mandible. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;103:e6-8.

46. Castro-Núñez J, Rey D, Amaya L. An innovative intracystic negative pressure system to treat odontogenic cysts. J Craniofac Surg 2017;28:1883-4.

47. Castro-Núñez J. Distraction sugosteogenesis: Its biologic bases and therapeutic principles. J Craniofac Surg 2018;29:2088-95.

48. Jia S, Li B. Osteosarcoma of the jaws: Case report on synchronous multicentric osteosarcomas. J Clin Diagn Res 2014;8:ZD01-3.

49. Alkan EA, Parlar A, Yildirim B, Sengüven B. Histological comparison of healing following tooth extraction with ridge preservation using enamel matrix derivatives versus Bio-Oss Collagen: A pilot study. Int J Oral Maxillofac Surg 2013;42:1522-8.

50. Yim JH, Lee JH. Panoramic analysis about spontaneous bone regeneration after enucleation of jaw cyst. J Korean Assoc Maxillofac Plast Reconstr Surg 2009;31:229-33.

51. Mc JL, Pan JL, Tan BS, Cui FZ. Determination of critical size defect of minipig mandible. J Tissue Eng Regen Med 2009;3:615-22.

52. Tolstunov L, Treasure T. Surgical treatment algorithm for odontogenic keratocyst: Combined treatment of odontogenic keratocyst and mandibular defect with marsupialization,
enucleation, iliac crest bone graft, and dental implants. J Oral Maxillofac Surg 2008;66:1025-36.
53. Kaczmarzyk T, Mozia I, Stypulkowska J. A systematic review of the recurrence rate for keratocystic odontogenic tumour in relation to treatment modalities. Int J Oral Maxillofac Surg 2012;41:756-67.
54. Chrzanovic BR, Gomez RS. Recurrence probability for keratocystic odontogenic tumors: An analysis of 6427 cases. J Craniomaxillofac Surg 2017;45:244-51.
55. Carlos NC, Cristina MM, Santiago JOC, Carlos NV. Mandibular reconstruction. In: Carlos Navarro Vila, editor. Reconstructive Oral and Maxillofacial Surgery. London, UK: Springer; 2015. p. 1-39.
56. Augustin MM, Joke D, Bourleyi SI, Shenda LP, Fidele NB, Van TM, et al. The effect of partial removable denture use on oral health related quality of life and masticatory function, after 5 years use. Open J Stomatol 2016;6:201-10.
57. Karen Ch, Stoelinga PJ, Peter W, John B, Ralph V. Rational approach to diagnosis and treatment of ameloblastomas and odontogenic keratocysts. Brit Oral Maxillofac Surgery 2004;42:381-90.
58. Poramate PA, Chaine A, Nicoleta O, Kittipong D, Jacques-Charles B. Management of odontogenic keratocysts of the jaws: A ten-year experience with 120 consecutive lesions. J Cranio-Maxillofac Surg 2010;38:358-64.