

Management and recurrence of keratocystic odontogenic tumor: a systematic review

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Objectives. The objective of this study was to evaluate the most up-to-date treatment modalities and respective recurrence rates for keratocystic odontogenic tumor (KCOT).

Study Design. A systematic review of the literature from 1999 to 2010 was undertaken examining treatment and recurrence rates for KCOT. Four inclusion criteria were defined for articles to then be analyzed against 8 standards.

Results. Of the 2736 published articles, 8 met the inclusion criteria. When merging the data, enucleation and enucleation with adjunctive measures (other than Carnoy's solution) had recurrence rates of 25.6% and 30.3%, respectively.

Marsupialization with adjunctive measures produced a recurrence rate of 15.8%, whereas enucleation with Carnoy's solution presented a recurrence rate of 7.9%. Only one resection case had recurrence (6.3%).

Conclusions. The enucleation technique with the use of adjunctive procedures (other than Carnoy's solution) provides a higher recurrence rate than any other treatment modality. (Oral Surg Oral Med Oral Pathol Oral Radiol 2012;xx:xxx)

Keratocystic odontogenic tumor (KCOT) is a unique lesion because of its locally aggressive behavior, high recurrence rate, and characteristic histologic appearance.^{1,2} Management of KCOT remains controversial owing to multiple different treatment protocols with varying recurrence rates. Historically, the following modalities have been used in the management of KCOT: decompression, marsupialization, peripheral ostectomy with application of Carnoy's solution, or liquid nitrogen cryotherapy; with most options supplementing the enucleation technique. Resection generally has been reserved for patients who have undergone several surgical procedures to remove the same recurring KCOT.³⁻⁸ Patients also tend to require long follow-up because of the nature of KCOT and its intrinsic position in nevoid basal cell carcinoma syndrome (NBCCS).^{1,2}

To date, no randomized controlled trials have been undertaken to establish which treatment modality pro-

vides the lowest recurrence rate. A review of the literature is the best available technique without the ethical dilemma inherent in a clinical trial, to determine recurrence rates for the contrasting surgical options and the most appropriate management of this lesion. A systematic review by Blanas et al.,⁹ published in 2000, included studies from 1970 to 1998. The aim of this current systematic review was to provide an update on the management and recurrence rates of KCOT, building on the work from Blanas et al.⁹ The data from 1999 to 2010 were analyzed and compared with the data from Blanas et al.⁹ The data were then combined to provide a current consensus on management and up-to-date recurrence rates for the different treatment modalities.

MATERIAL AND METHODS

Blanas et al.⁹ conducted an English literature search using the keywords "keratocyst," "odontogenic cyst," "basal cell naevus syndrome," "keratin," and "cyst" to identify articles that discussed treatment or prognosis of KCOT. The authors defined 4 inclusion criteria for articles to be selected and then tested the reported results against 8 parameters (Table I). To compare articles published after 1998 with those in the Blanas et al.⁹ review, the same inclusion criteria and standards were used in this current review, as described by Blanas et al.⁹ in Table I. By replicating the Blanas et al.⁹ methodology, this enabled the results from both review processes to be combined. It was a requirement for the selected articles to state whether or not they included patients with NBCCS in their cohorts.

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Table I. Criteria from Blanas et al.⁹ in selecting appropriate articles to review

<i>Inclusion criteria</i>	<i>8 standards of inclusion</i>
1. Keratocystic odontogenic tumor was diagnosed by histopathologic evaluation.	1-4. Inclusion criteria.
2. Patient selection process was adequately described and consisted of consecutive patients.	5. Assembly of an inception cohort—identifying patients at an early and uniform stage of disease to assess the clinical course of the disease.
3. An adequate description was given of the follow-up period.	6. Documentation of adverse outcomes.
4. Treatment rendered was specified in sufficient detail to repeat the procedure, with each treatment being correlated with a recurrence rate.	7. Adequate clinical and demographic information—to observe whether each of the study groups had a similar set of patients.
	8. Unbiased surveillance of patients—evaluate for adverse outcomes, systematic use of objective methods and criteria for determining outcomes and having the evaluation blinded to treatment and prior events.

RESULTS

Using the keywords described in the preceding paragraph, 2736 articles were identified. Limiting the search between the 1999 and 2010 produced 206 articles, with 28 articles having consecutive cases. Eight articles (Table II) met the inclusion criteria, which were then analyzed using the 8 standards.

All studies confirmed that histopathology was used to diagnose the KCOTs (Criterion 1). Most cases were reviewed retrospectively, with 1 study prospective, but all were consecutive (Criterion 2). Follow-up periods were provided in all studies (Criterion 3); however, the reporting of this varied between authors. Some stated a range for follow-up, whereas others provided an average length of time. Treatment modalities were described in adequate detail so that they could be repeated if necessary, with recurrence rates provided for each treatment option (Criterion 4). The different treatment modalities located in the literature and described by Blanas et al.⁹ are presented as follows:

1. **Curettage** is the method where the wall of the cyst cavity is surgically scraped with the removal of its contents.¹⁴
2. **Enucleation** is the removal of a lesion intact.¹⁵ As the lining of the cyst may be friable and thin, removal of the cyst in one piece is difficult.¹⁶ To combat this feature, a number of studies suggest that the general treatment of the primary KCOT should include enucleation of the cyst, followed by mechanical curettage using methylene blue as a marking agent, followed by a 3-minute application of Carnoy's solution (a tissue fixative).^{1,3,8,15-19} This treatment option has the advantage of preservation of the adjacent bone, soft tissue, and dental structures. This results in reduced morbidity and cost of treatment.^{8,16,20}

The general chemical make-up of Carnoy's solution is a ratio of absolute alcohol (6 mL) chloroform (3 mL), glacial acetic acid (1 mL), and ferric chloride (1 g).^{10,20-22} The original description on the use of Carnoy's solution was to place it into the cyst cavity before enucleation¹⁵; however, most clinicians apply it to the bony cavity after enucleation.^{15,18}

3. **Radical enucleation** involves removal of the entire cyst lining together with any associated overlying mucosa, followed by extensive cavity curettage with reduction of the surrounding bone to remove residual cystic epithelium.²³ This treatment option is very similar to conventional enucleation without the use of adjunctive measures.^{8,15-19}
4. **Marsupialization (also known as decompression)** is the process of exteriorizing the internal cyst contents by resecting the superficial wall and suturing the cut edges of the remaining wall to adjacent mucosa.^{24,25} Marsupialization is proposed as a non-destructive and a more physiologically acceptable treatment method,²⁴ as Carnoy's solution is not used and there is minimal surgical morbidity.¹¹
5. **Resection** refers to either segmental resection or marginal resection—mainly undertaken in the mandible.²² The difference between the 2 techniques is that segmental resection removes a whole section of bone with loss of continuity of the bone, whereas marginal resection maintains the continuity of the inferior or posterior borders of the mandible.²²

Most studies excluded patients with NBCCS, with the only exception being Nakamura et al.¹² Five of 28 patients had NBCCS with only 1 having recurrence. It is uncertain when this recurrence occurred, as the authors provided only an average follow-up time (3-14 years).¹² As Blanas et al.⁹ included studies with pa-

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