Journal of Cranio-Maxillo-Facial Surgery 45 (2017) 1165–1169

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

# Can cyst volume be used to stratify risk of complications following cyst defect reconstruction with iliac crest graft?

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ARTICLE INFO

*Article history:*
Paper received 13 November 2016
Accepted 10 May 2017
Available online 17 May 2017

*Keywords:*
Cyst volume
Segmentation
Complications
Iliac crest graft

ABSTRACT

*Introduction:* The role of the volume of radicular and dentigerous cysts on clinical symptoms is unclear and potentially may predict development of pre- and postoperative complications, especially after cystectomies with large bony defects. Therefore the aim of this study was to assess pre- and postoperative symptoms associated to the volume of jaw cysts.
*Material and methods:* Retrospective chart review of 111 patients with follicular or dentigerous cysts from 2008–2012. Anterior iliac crest grafts were used to fill defects after cystectomy. $\chi^2$-test was performed to analyze associations between two qualitative variables. Binary logistic regression analysis was used as multivariate analysis. P-values $p < 0.05$ were considered as significant. Volume measurement was performed in a semiautomatic segmentation method with the software "ITK-Snap".
*Results:* Postoperative hypaesthesia correlated significantly with histology ($p = 0.025$) and localization ($p = 0.006$). Volume was associated significantly with preoperative hypaesthesia ($p = 0.052$), postoperative hypaesthesia ($p < 0.001$), wound healing complications ($p < 0.001$) and length of wound healing complications ($p = 0.001$). Multivariate analysis identified volume as independent risk factor for postoperative hypaesthesia ($p = 0.015$).
*Conclusions:* Volume analysis appears to be a method that allows risk stratification after surgery of jaw cysts. Therefore we recommend a precise treatment planning with the means of volume analysis to improve therapy outcome of patients with jaw cysts.


## 1. Introduction

Jaw cysts represent common lesions in the oral and maxillofacial region (Swantek et al., 2012). They are defined as a pathological cavity which is not created by the accumulation of pus and which contains fluid, semifluid or gaseous contents (Kramer, 1974). The most common odontogenic cysts are radicular (56%) and dentigerous cysts (17%) (Manor et al., 2012). In the early stages, odontogenic cysts often go along with unspecific symptoms and are commonly diagnosed incidentally through routine panoramic radiographs (Ochsenius et al., 2007). A major help in evaluating the anatomic extension of cystic lesions and adjacent structures, such as the neurovascular bundle, maxillary sinus, nasal cavity or inferior alveolar dental nerve, is the use of cone beam computed tomography (Vallaeys et al., 2015; Ochsenius et al., 2007). Particularly for large cysts, three-dimensional imaging is regularly performed in clinical routine (Vallaeys et al., 2015). Although this technique enables volumetric analysis of cysts, it is still performed rarely, whereas the diameter of cystic lesions is measured routinely (Suter et al., 2015). In multiple studies, the size of the cysts was demonstrated to be an independent risk factor for complication rates (Ettl et al., 2012). However, data on the volume of cysts is lacking. In 2015, Suter et al. could demonstrate that an increased volume of nasopalatine duct cysts led to a higher risk of complications; hence, they suggested volume analysis as a helpful parameter for risk stratification, which may improve patient individualized treatment (Suter et al., 2015). Nevertheless, a study specifically focusing on radicular and dentigerous cysts, being the most common

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http://dx.doi.org/10.1016/j.jcms.2017.05.010
1010-5182/

odontogenic cysts, does not exist. Therefore we aimed to evaluate the importance of volumetric analysis as a risk parameter for complications after cystectomy following reconstruction with iliac crest graft (Figs. 1–3).

## 2. Materials and methods

### 2.1. Patients and data collection

Our investigation followed the guidelines of the Declaration of Helsinki. The retrospective study included 111 patients from 2008 to 2012 at the Department for Oral and Craniomaxillofacial Plastic Surgery, University of Cologne, Germany. The inclusion criteria were treatment naive cystic jaw lesions, preoperative cone beam computed tomography (CBCT), and harvesting of iliac crest graft performed according to the described standard surgical technique of our clinic and radicular and dentigerous cysts as histological entities. Due to the retrospective nature of this study, it was granted an exemption in writing by the University Hospital of Cologne institutional review board.

Clinicopathologic data were collected from medical records as well as pathology and surgery reports. Parameters were carefully reviewed and are listed in Table 1.

We defined cysts larger than the median volume of $4.56^3$ cm as large cysts and smaller than the median volume as small cysts. Hypaesthesia was assessed preoperatively and postoperatively at 2 weeks. As a valid method for testing the sensory innervation of trigeminal branches, we carried out a repeated test with the sharp and blunt ends of a dental probe according to Schultze-Mosgau et al. (2001) and Essick (1992). We performed this method by gently stroking over the facial skin without penetrating the skin with the point of the probe. According to this method, a diagnosis of hypaesthesia was made, whenever the patient was not able to successfully identify 4 out of 4 tests (Schultze-Mosgau et al., 2001; Cricchio and Lundgren, 2003).

### 2.2. Volume measurement

To measure the volume of the cysts, we used the open source software ITK-SNAP (Penn Image Computing and Science Laboratory) (Yushkevich et al., 2006). The CBCT DICOM datasets were imported to ITK-Snap and were demonstrated in sagittal, coronal and axial slices. The cysts were identified and delineated with the means of semiautomatic segmentation. Afterwards, manual segmentation was performed to ensure correct segmentation. The volume of the cysts was computed automatically in cubic millimetres by the software.

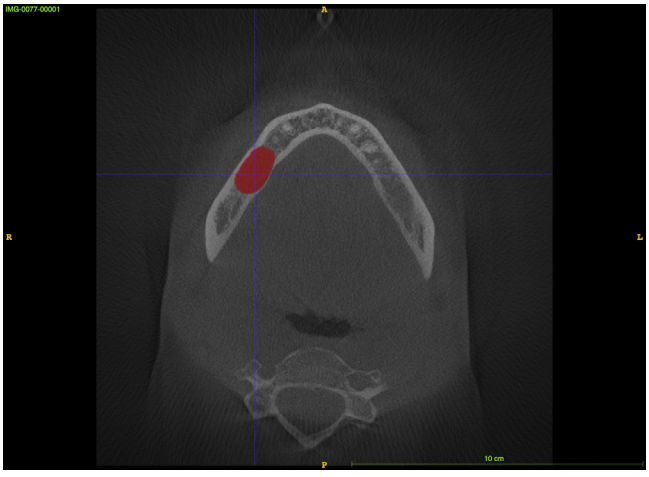

**Fig. 1.** Segmentation of jaw cyst in axial plane.

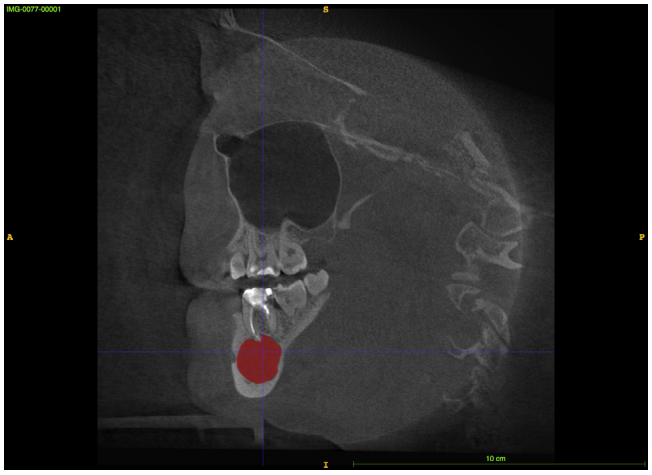

**Fig. 2.** Segmentation of jaw cyst in sagittal plane.

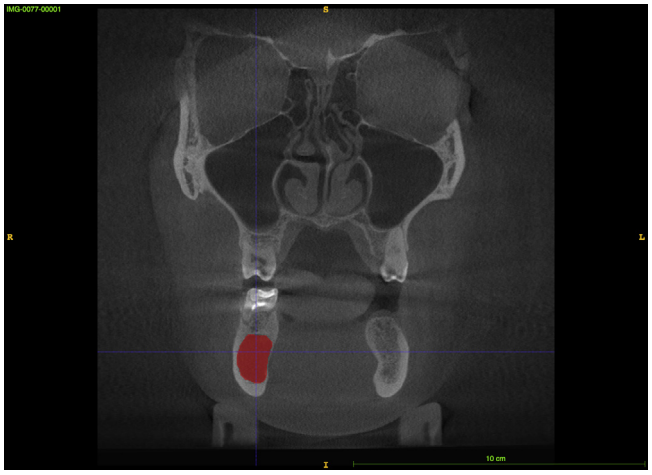

**Fig. 3.** Segmentation of jaw cyst in coronal plane.

A validated method of performing morphometry and volume analysis based upon CBCT imaging is tissue segmentation (Vallaeys et al., 2015). This technique is based upon manually, semiautomatic and automatic methods (Dastidar et al., 1999). Semiautomatic segmentation combines the efficiency and repeatability of automatic segmentation and the correct delineation of manual segmentation (Dastidar et al., 1999). The open-source medical imaging program ITK-SNAP (Penn Image Computing and Science Laboratory) offers manual and semiautomatic tools to analyze the volumes of different anatomical regions, and is based on geodesic active contour and region competition methods (Yushkevich et al., 2006). Validation of this program for segmentation and volume measurement has been shown for the caudate nucleus of the brain. A large number of further studies confirmed these results (Vallaeys et al., 2015).

### 2.3. Statistical analysis

The $\chi^2$ test was performed to analyze associations between two qualitative variables. Binary logistic regression analysis was used as multivariate analysis. A p value of $<0.05$ was considered to be