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Original Research

Clinical Significance of CBCT Findings in the Treatment of Maxillary Cysts Expanded Into the Nasal and Sinus Cavities

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ABSTRACT

Objective: We aimed to retrospectively assess the importance of the radiological findings from the cone-beam computed tomography (CBCT) data on the treatment of maxillary cysts extending into the nasal and maxillary sinus cavities.

Methods: Thirty-three consecutive patients with maxillary intraosseous odontogenic cysts that extended into the nasal and maxillary cavities were included in the present study. The CBCT signs of the lesions were classified into three subgroups for lesions extending into the maxillary sinus and divided into four subgroups for lesions extending into the nasal cavities. Age, gender, cyst type, location, presence of cortical bone expansion/resorption, root displacement, lacunarity (unilacunar and multilacunar), and lesion dimensions were also evaluated. All the patients were treated with only enucleation, only decompression, or decompression after enucleation. Here, $p<0.05$ was considered to be statistically significant.

Results: Patients (13/39.4% females and 20/60.6% males) were in the age range from 8 to 65 years (mean age: 30.42±12.74 years). Here, 23 cases, (69.7%) exhibited both buccal and palatine bone resorption as compared to only cortical resorption in the coronal CBCT slices. The cysts' dimensions were calculated from the axial, coronal, and sagittal slices as 24.58±8.56, 24.94±9.74, and 26.45±7.88 mm, respectively. There were no statistically significant differences between both the subgroups of the CBCT findings of lesions extending in the nasal area or maxillary sinus as well as the three treatment modalities ($p>0.05$).

Conclusion: The resorption of the lateral nasal wall and cortical floor, particularly in the nasal region, and the findings of narrowing of the airway may affect treatment planning, even if the obtained results were not statistically significant.

Keywords: Cone-beam computed tomography, decompression, enucleation, odontogenic cyst

INTRODUCTION

Odontogenic cysts are frequently encountered lesions in the maxillofacial region. Such entities that appear in the maxillary region may lead to the formation of granuloma-like lesions when restricted within the alveolar bone; sometimes, they can result in the resorption and/or expansion of the buccal and palatine cortical bones, as well as cause root resorption or displacement when related to the tooth-bearing areas (1, 2). For cases in which the lesions extend into the maxillary sinus or nasal cavity or both, more complicated findings may arise even without any symptoms. In particular, the potential cavity of the maxillary sinus results in lesion enlargement. It has been reported that large-volume lesions, such as radicular cysts (3), dentigerous cysts (4), and odontogenic keratocysts (5, 6), which are not confined within the maxillary alveolar bone, can extend toward the sinus and nasal areas.

It has also been reported that cases involving the maxillary sinus are related to symptoms such as facial swelling, epiphora related to nasolacrimal duct obstruction, orbital proptosis, and tooth displacement to the orbital floor caused by dentigerous cysts (3, 6, 7). Symptoms in the nasal region are generally limited to nasal floor resorption and/or expansion, leading to nasal airway narrowing and septal deviation (7).

Conventional radiographic techniques are inadequate to diagnose cystic lesions seen in the middle face region because of the region's complex three-dimensional structure. Therefore, computed tomography (CT) is the most popular technique that is preferred for observing details of the bone structures (1). However, in the recent years, cone-beam computed tomography (CBCT) has become increasingly popular than conventional CT in the dental field. In particular, it provides better image resolution

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with less radiation and cost as compared to those resulting from conventional CT (8).

The present study aims to determine the different radiological signs of maxillary odontogenic cysts that extend into the maxillary sinus and nasal cavities observed on the CBCT scans to help clinicians in appropriate treatment planning in favor of the patient.

METHODS

Patients

We designed a retrospective study comprising preoperative CBCT images of 33 patients. The patients were diagnosed and surgically, conservatively, or conservative+surgically treated with maxillary intraosseous odontogenic cysts at the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Gaziantep University, between December 2012 and November 2018. Informed consent forms were not required. since it was a retrospective study and archive data was used. The inclusion criteria were as follows: 1) maxillary cyst that resorbed or expanded at least one cortical region (buccal, palatal, or nasal/sinus floor cortices or anterior/lateral nasal wall), 2) the cyst extending into the maxillary sinus that changed the sinus membrane thickness, and 3) the cyst extending into the nasal cavity that resorbed the lateral nasal wall or nasal floor or restricted the nasal airway.

Cone-beam computed tomography images with inadequate data (e.g., the field of CBCT images did not extend into the entire cyst cavity) or that showed signs of previous operations, non-osseous jaw cysts, and presence of technical artifacts that could complicate the evaluations of the maxillary sinus and nasal cavities were excluded. Case records were retrieved from the archives, and each patient's age, gender, cyst type, location, presence of cortical bone expansion/resorption, root displacement, lacunarity, dimensions of lesions, and treatment modality were also evaluated.

A total of 33 cases with CBCT records (24 radicular cysts, 5 dentigerous cysts, 2 odontogenic keratocysts, 1 nasopalatine duct cyst, and 1 glandular odontogenic cyst) obtained from 20 males and 13 females (age range: 8–65 years; mean age: 30.42±12.74 years) were ultimately included in the present study. The ethical approval for this retrospective study was obtained from the Ethics Committee of the Gaziantep University (2018/271, November 21, 2018).

CBCT Acquisition

All the CBCT images were obtained using the same scanner (Planmeca, ProMax, Helsinki, Finland) using a voxel size of 200 µm, field of view of 200 × 170 mm, and high resolution. The axial, sagittal, and coronal sections were imaged, and the images were analyzed using special CBCT software (Romexis, Planmeca, Helsinki, Finland). The exposure settings were 5.0–7.0 mA and 80 kV for an exposure time of 17.5 s. The data were reconstructed with slices at an interval of 1.2 mm.

Main Points:

- CBCT provides detailed radiographic data before surgical intervention.
- Huge cysts in maxilla may cause narrowing of the nasal airway.
- CBCT examination prevents permanent complications.

Assessment of CBCT Images

The observations were carried out under dimmed lighting and a black background. Images were viewed with a 24 inch UltraSharp LED TFT Monitor (Dell, USA) that displayed 2 megapixels at a pitch of 0.27 pixels. All the images were evaluated by the first author.

Determination of Cyst Dimensions and Localization

Intraosseous cysts that were located in the anterior/posterior maxillary regions expanding to the nasal cavity or maxillary sinus were radiographically identified as having a well-demarcated radiolucent unilocular or multilocular appearance, and their dimensions were measured on CBCT slices across all the three planes (coronal, axial, and sagittal) in millimeters. The longest diameter in the vertical direction was measured in the coronal section. The longest buccopalatal direction in the axial section and the most anterior–posterior dimension in the sagittal view were calculated.

The localization of cysts was mainly divided into three groups: anterior (canine to canine), posterior (canine to posterior), and anterior–posterior (lesion located on both the anterior and posterior regions).

Examination of Maxillary Sinus Affected by Cystic Lesions

On the axial CBCT slices, pathological findings obtained from the cystic lesions that expanded into the maxillary sinus were categorized as follows: 1) No pathological changes (MS_1); 2) resorption on the sinus wall and expansion into the sinus cavity with chronic sinusitis (MS_2); and 3) resorption on the sinus wall and expansion into the sinus cavity with total opacification (MS_3) (Figure 1a-c), respectively.

Examination of Nasal Cavity Affected by Cystic Lesions

On the coronal CBCT slices, the pathological findings obtained from the cystic lesions that expanded into the nasal cavity were categorized as follows: 1) No pathological changes (NC_1); 2) only resorption into the nasal floor cortical or lateral nasal wall (NC_2); 3) nasal floor expansion into the cavity with narrowing of the nasal airway (NC_3); and 4) resorption in the nasal floor cortical with expansion into the cavity, leading to narrowing of the nasal airway with septum deviation or thickness in the nasal mucosa (NC_4) (Figure 2a-d), respectively.

Surgical Procedures

All the patients included in this study underwent three different treatment modalities: surgical; conservative enucleation (removal of the cyst epithelial lining) and decompression (decreasing the intracystic pressure by stimulating new bone formation); conservative+surgically (decreasing the cyst volume by decompression and subsequent enucleation). All the treatments were performed under local anesthesia.

Figure 1. a-d. Pathological findings of cysts invading into the maxillary sinus. (a) no pathological changes (MS_1). (b) resorption on the sinus wall and expansion into the sinus cavity with chronic sinusitis (MS_2). (c) resorption on the sinus wall and expansion into the sinus cavity with total opacification (MS_3)

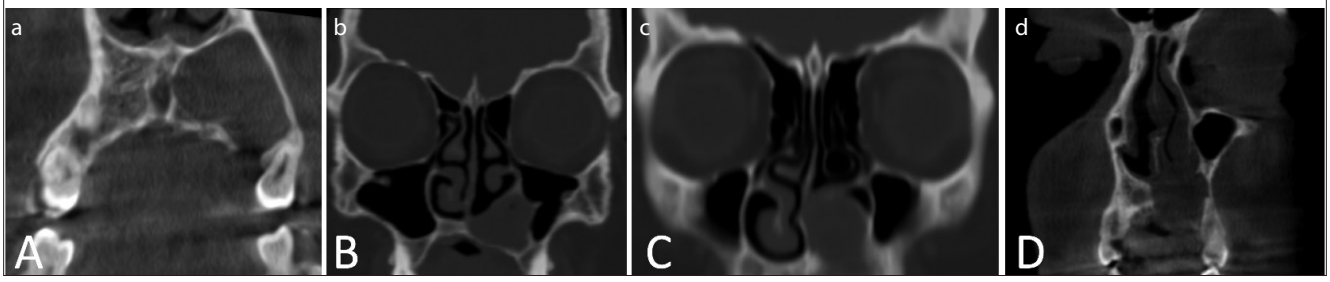
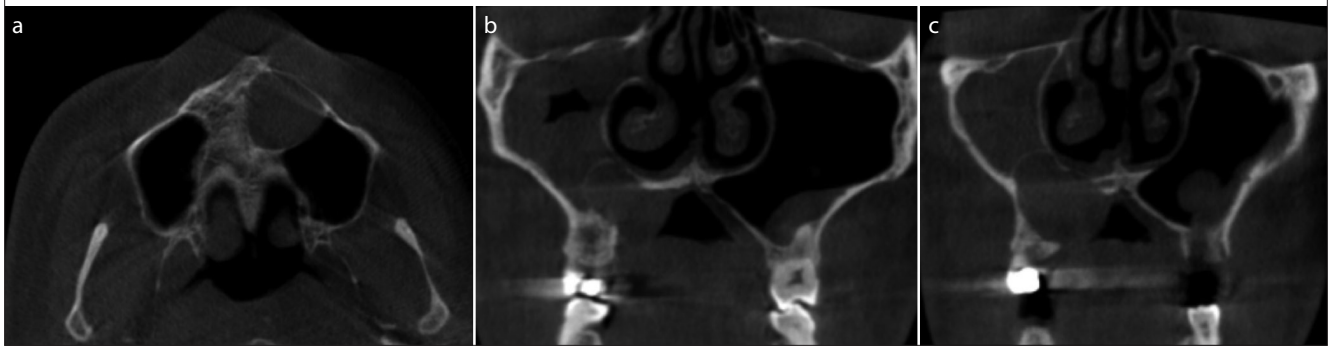


Figure 2. a-c. Pathological findings of the cysts invading into the nasal cavity. (a) no pathological changes (NC_1). (b) only resorption in the nasal floor or lateral nasal wall cortices (NC_2). (c) nasal floor expansion into the cavity with narrowing of the nasal airway (NC_3). (d) resorption in the nasal floor cortical region with expansion into the cavity, leading to narrowing of the nasal airway with septum deviation or thickness in the nasal mucosa (NC_4)



Statistical Analysis

All the values were shown as mean±deviation and all the analyses were performed using the IBM Statistical Package for the Social Sciences (IBM SPSS Corp.; Armonk, NY, USA) version 25.0 software. One-way ANOVA test was used for comparing the independent groups and post-hoc Tukey's test was performed for subgroup comparisons. The intraoperator reliability of the scores recorded by the same observer was examined by the intraclass correlation coefficient for an interval of at least 2 months, which yielded a 95% agreement rate. Here, $p<0.05$ was considered to be statistically significant.

RESULTS

The CBCT images of 33 patients were evaluated, which included 13 females (39.4%) and 20 males (60.6%). The age ranged from 8 to 65 years (mean age: 30.42±12.74 years). Here, 24 cases were radicular cysts (72.7%), 5 were dentigerous cysts (15.2%), 2 were odontogenic keratocysts (6.1%), 1 was nasopalatine duct cyst (3%), and 1 was glandular odontogenic cyst (3%). Further, 9 cases (27.2%) were located in the anterior region, 12 (36.4%) were in the posterior region, and 12 (36.4%) cases were extended in both the regions. More cases (23 cases, 69.7%) were present with both buccal and palatine bone resorption as compared to only cortical resorption in the coronal CBCT slices. Similarly, expansions in both the cortical regions were seen in more cases (19 cases, 57.6%) as compared to only cortical expansion. Such cases show only one finding in the buccal or palatine region (expansion or resorption), namely, these lesions tended to expand to the buccal side or undergo resorption on the same side (buccal expansion: 7/21.2% cases; buccal resorption: 5/15.1%). Only 9 cases (27.3%) exhibited root displacement. All the cases exhibited the unilocular radiographic appearance. With regard to the cyst dimensions, the mean axial, coronal, and sagittal measurements were calculated to be 24.58±8.56, 24.94±9.74, and 26.45±7.88 mm, respectively. Table 1 lists the clinical and radiological findings of 33 maxillary cysts with axial, coronal, and sagittal dimensions.

When evaluating the CBCT findings of the cysts that extend into the nasal cavity and maxillary sinus, 9 cases (27.3%) exhibited the MS_1 finding; 17 (51.6%) cases, the MS_2 finding; and 7 (21.1%) cases, the MS_3 finding. No pathological finding in the nasal cavity (NC_1) was found in 8 (24.3%) cases. The CBCT findings of NC_2, NC_3, and NC_4 were seen in 14 (42.5%), 5 (15.1%), and 6 (18.1%) cases, respectively. There were no statistically significant differences between both the subgroups of the CBCT findings of lesions extending into the nasal area or maxillary sinus as well as the three treatment modalities.

Out of the 33 treated cases, decompression was performed in 3 cases, enucleation in 15 cases, and decompression after enucleation in 15 cases. Follow-up was performed for at least one year; no recurrence was observed in all the lesions.

Data regarding the distribution of the different treatment methods applied to the lesions according to the maxillary sinus or nasal cavity findings are listed in Tables 2 and 3, respectively.

Table 1. Clinical and radiological findings of 33 maxillary cysts with axial, coronal, and sagittal dimensions (mm)

Characteristics	
Age range, years (mean±SD)	8–65, 30.42±12.74
	(n/%)
Gender	
Male	20/60.6
Female	13/39.4
Diagnosis of cyst	
Radicular cyst	24/72.7
Dentigerous cyst	5/15.2
Odontogenic keratocyst	2/6.1
Nasopalatine duct cyst	1/3
Glandular odontogenic cyst	1/3
Location	
Anterior	9/27.2
Posterior	12/36.4
Both regions	12/36.4
Cortical bone expansion	
No resorption	3/ 9.1
Buccal only	7/21.2
Palatine only	0/0
Buccal and palatine	23/69.7
Cortical bone resorption	
No resorption	8/24.3
Buccal only	5/15.1
Palatine only	1/3
Buccal and palatine	19/57.6
Root displacement	
Displacement	9/27.3
No displacement	24/72.7
Radiographic appearance	
Unilocular	33/100
Multilocular	0/0
Cyst dimensions (mean±SD, mm)	
Axial	24.58±8.56
Coronal	24.94±9.74
Sagittal	26.45±7.88

DISCUSSION

The maxillary region, which is in the midface area, makes it difficult for surgeons to treat cystic lesions due to the complicated anatomical bone structure in this region. Although the radiographical features of the pathological findings caused by maxillary cysts are reported in detail in other case reports (3, 5-7, 9), case series are limited (10, 11).

It is well known that clinical and radiographical findings affect the treatment planning of odontogenic cysts. For cysts in which the lesions expand into larger volumes with weak cortical bones or when surgical intervention causes inferior alveolar nerve damage and tooth buds or inadvertent injury to the adjacent structures, decompression or marsupialization is highly recommended in many studies employing CBCT or CT techniques (12, 13). These radiographical techniques yield more detailed bone structures, particularly in the midface region, as compared to those obtained from conventional 2D graphs. CBCT is superior to CT because of its advantages such as low radiation dose, high resolution, easy handling, and low cost in the evaluation of maxillofacial pathologies.

In this study, we retrospectively aimed to evaluate if the radiographical findings obtained from CBCT slices influence the treatment planning of maxillary cysts extending into the maxillary sinus and nasal region. It was found that the maxillary sinus and nasal region findings divided into different subgroups did not yield a statistical difference between the enucleation, decompression, and enucleation following decompression treatments applied to such cysts. The low number of cases in these subgroups may lead to this outcome; therefore, this can be considered as a demerit of the present study.

As mentioned earlier, the detailed radiographic data on large-volume maxillary cysts are usually limited by the individual case reports. The clinical experience of the surgeon performing the treatment with different clinical and radiographical findings of the lesion can result in a lack of standardization in the treatment planning of such cases. In similar cases, one surgeon may perform decompression (14), while another surgeon may perform enucleation (9) or assist with endoscopic enucleation (5). On the other hand, the different histopathological features of the cysts may affect their clinical behavior, and the results of similar treatments may be different. Gao et al. (15) reported that an increase in the bone density was more significant in radicular cysts than that in keratocystic odontogenic tumors (KCOTs). We believe that the lack of standardization in the cyst type is another limitation of the present study. This is due to the retrospective nature of this study.

Anteriorly located maxillary lesions expanding into the nasal cavity and posterior lesions mostly expand into the sinus. Lesions extending into the sinus may occasionally fill the sinus, but ophthalmologic complications may rarely occur, such as proptosis, exophthalmos, diplopia, ptosis, or decreased visual acuity by resorbing the orbital floor (16). Since no ophthalmologic symptoms or radiographical findings were detected in any of these cases, the classification of the findings in this study was limited to the maxillary sinus and nasal region.

Table 2. Distribution of different treatment methods for cysts according to maxillary sinus findings

		Decompression	Enucleation	Decomp+Enuc	p
Maxillary sinus findings (n/%)	MS_1 (9/27.5)	2/6.2	4/12.2	3/9.1	>0.05
	MS_2 (17/51.3)	1/3	9/27.1	7/21.2	
	MS_3 (7/21.2)	0/0	2/ 6.1	5/15.1	
	Total	3/9.2	15/45.4	15/45.4	33/100

Table 3. Distribution of the different treatment methods according to the findings of lesions extending into the nasal cavity

		Decompression	Enucleation	Decomp+Enuc	p
Nasal cavity findings (n/%)	NC_1 (8/24.2)	0/0	6/18.1	2/6.1	>0.05
	NC_2 (14/42.4)	2/6.2	6/18.1	6/18.1	
	NC_3 (5/15.1)	1/3	1/ 3	3/9.1	
	NC_4 (6/18.3)	0/0	2/6.2	4/12.1	
	Total	3/9.2	15/45.4	15/45.4	33/100

Inflammatory cysts may affect the sinus mucosa, with or without perforating the cortical bone of the maxillary sinus from areas where the bone is weak (17). In this study, chronic sinusitis or total opacification with maxillary sinus invasion was detected in a majority of the cases (n=24). Further, as indicated in the literature, a thin cortical radiolucent boundary may be recognizable on the CBCT or CT slices between the sinus cavity and the cyst in the lesions extending into the sinus, unless the cyst becomes infected. This thin cortical line is important in the diagnosis of cysts (18). This also explains why 72.5% of such lesions, which extend into the maxillary sinus, are radicular cysts originating from the nonvital tooth. These cysts may cause chronic infection in the sinus. While decompression was applied to only 1 of these cysts, the 12 remaining lesions (MS_2 findings: 7 cases; MS_3 findings: 5 cases) were treated with enucleation following decompression.

The lateral nasal wall or nasal cortical floor resorption and narrowing of the airway findings caused by resorption were effective in our treatment planning. In large-volume cases treated without decompression, the cyst epithelial remnants may remain as it is difficult to completely remove the cyst epithelium from the mucosa of the nasal base, resulting in recurrence in the postoperative period. Due to the rich vascular supply of the nasal mucosa, bothersome bleeding may occur during surgery. In the treatment of such lesions, it was primarily aimed to reduce the lesion by decompression (NC_2: 6 cases; NC_3: 3 cases; NC_4: 4 cases) and then the cyst epithelium was removed by enucleation.

CONCLUSION

Although the results obtained are not statistically significant, it can be stated that the resorption of the lateral nasal wall and cortical floor, particularly in the nasal region, and findings of narrowing in the airway affect treatment planning. The large volume of the cyst can be reduced by decompression once a sufficient amount of bone is regained in order to prevent damage to the adjacent vital structures in the midface and therefore the subsequent surgery becomes safer.

Ethics Committee Approval: The ethical approval for this retrospective study was obtained from the Ethics Committee of the Gaziantep University (2018/271, 21.11.2018).

Informed Consent: Due to the retrospective design of the study, informed consent was not taken.

Peer-review: Externally peer-reviewed.

Author contributions: Concept – M.Y., M.D.; Design – M.Y., M.D.; Supervision – M.D.; Data Collection and/or Processing – M.Y.; Analysis and/or Interpretation – M.Y.; Literature Search – M.Y.; Writing – M.D.; Critical Reviews – M.D.

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