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Clinic and Cone beam computed tomography characterization of the bone maxilofacial lesions from Estomatology Clinic

Caracterização clínica e por tomografia computadorizada de feixe cônico de lesões ósseas maxilofaciais da clínica Clínica de Propedêutica Estomatológica

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ABSTRACT

Objective: To characterize the maxillofacial bone lesions by associating clinical and imaging aspects, through Cone Beam Computed Tomography (CBCT) and compare the findings with those reported by the literature. **Material and Methods:** Twelve files were selected from the Clinics of Stomatological Propedeutics (ICT-UNESP) reporting maxillofacial bone lesions with previous CBCT indication. CBCT was carried out with i-CAT Next Generation scanner (imaging Sciences International, Hatfield, PA, USA) at the Radiology Clinics of the institution. First, we recorded the clinical information on gender, age range, and main complaints. Then, CBCT images were assessed regarding to: site, lesion internal architecture and limits, effect on bone corticals, effect on teeth and support structures, and the lesion internal aspects. All images were evaluated with the aid of i-CAT Vision software at multi-planar reconstruction model (MPR). **Results:** We studied four root cyst lesions, two keratocystic odontogenic tumors, one compound odontoma, one odontogenic hamartoma, one focal osseous dysplasia, one calcifying cystic odontogenic tumor, and two fibrous scars. CBCT helped in achieving the diagnosis because of tridimensionality, but sometimes, the lesion characteristics disagreed from those described in the literature because the latter were based on two-dimensional radiographs. **Conclusion:** CBCT is highly valuable in characterizing bone lesions, but the literature demands a specific approach for CBCT images because the latter differs from conventional radiographic images.

KEYWORDS

Radiograph; Cone Beam Computed Tomography; Odontogenic Tumors.

RESUMO

Objetivo: Caracterizar as lesões ósseas da região maxilofacial conjugando seus aspectos clínicos aos imaginológicos, por tomografia computadorizada de feixe cônico (TCFC), comparando estes achados da literatura. **Material e Métodos:** Foram selecionados 12 prontuários da Clínica de Propedêutica Estomatológica do ICT-UNESP, apresentando lesões ósseas na região maxilofacial, com prévia indicação de exame por TCFC, realizados em tomógrafo i-CAT Next Generation (imaging Sciences International, Hatfield, PA, EUA) na clínica de Radiologia da instituição. Foram levantadas informações clínicas como sexo, faixa etária e queixas principais. Avaliou-se as imagens de TCFC quanto: localização, arquitetura interna e limites da lesão, efeito nas corticais ósseas, efeito nos dentes e estruturas de suporte dentário e os aspectos internos da lesão. As imagens foram avaliadas no software i-CAT Vision do tomógrafo em janelas de reconstrução multiplanar (MPR). **Resultados:** Foram estudadas 04 lesões correspondentes a cistos radiculares, 02 a tumores odontogênicos queratocísticos, 01 a odontoma composto, 01 a hamartoma odontogênico, 01 a displasia óssea focal, 01 tumor odontogênico cístico calcificante e 02 cicatrizes fibrosas. A TCFC auxiliou na conclusão dos diagnósticos, visto sua característica de tridimensionalidade, houve, algumas vezes, divergências em relação aos achados descritos na literatura, eminentemente baseados radiografias bidimensionais. **Conclusão:** a TCFC é de grande valia na caracterização das lesões ósseas, observa-se uma necessidade na literatura de uma abordagem específica para esta modalidade de imagens, diferente das radiográficas convencionais.

PALAVRAS-CHAVE

Radiograph; Cone Beam Computed Tomography; Odontogenic Tumors.

INTRODUCTION

Cone Beam Computed Tomography (CBCT) is a method firstly introduced in Italy in 1997 [1], then commercially used since 2001 in USA [2]. Among CBCT advantages are the lowest radiation dose than that of Fan Beam Computed Tomography (FBCT), lack of image superposition, high spatial resolution of bone tissues, possibility of measuring the images, and obtainment of real distances between important maxillofacial anatomic structures, which justified the large use of CBCT[2-4].

The Computed Tomography (CT) images allowed the three-dimensional visualization of the structures and their alterations, characterizing them precisely and uniquely, which is essential for diagnosing and consequently the treatment planning, outdoing the conventional two-dimensional radiographic images.

Many maxillofacial lesions have bone alterations, from cysts and pseudo-cysts, odontogenic and non-odontogenic neoplasias to fibrous-osseous lesions. The literature [5-7] highlights among the most common bone lesions affecting the maxillofacial complex, the radicular cysts, ameloblastoma, keratocystic odontogenic tumor, osseous dysplasias, and the cemento-ossifying fibroma.

Different lesions require different treatment approaches. While osseous dysplasias require proservation, cemento-ossifying fibromas, odontogenic tumors, and cysts demand surgical treatment [5]. The keratocystic odontogenic tumor has a potentially destructive behavior and is locally prone to relapse[8]. Differential diagnosis from dentigerous cystic and unicystic ameloblastoma are necessary due to the images of well-defined cortical margins that may expand [6].

The histopathologic aspects of osseous lesions play a fundamental role in final diagnosis, but imaging examinations are very important for treatment planning and prognosis. Generally, the literature reports imaging findings of these lesions based mostly on conventional radiographs. Conventional radiographs have limiting factors for diagnosis hypotheses because of superimposition of structures and lack of providing fundamental information on the real extension of the lesions and their effects on surrounding structures. Accordingly, CBCT enables the characterization and real spatial location of the lesions, potentially helping in formulating the most likely diagnosis hypothesis for these lesions [6,8].

In this context, this study is very important and aimed to characterize the clinical and imaging aspects of maxillofacial osseous lesions obtained through CBCT and compare them with the literature reports from conventional radiographic images.

MATERIAL AND METHODS

This study was submitted and approved by the Institutional Review Board regarding ethical aspects (protocol CAAE 4503015.1.0000.0077). First, 35 files of patients treated in the Clinics of Stomatological Propedeutics of the Science and Technological Institute of the São Paulo State University Julio de Mesquita Filho (ICT-UNESP) were selected based on the presence of maxillofacial osseous lesions and indication for CBCT examination at the same institution. Of these, 12 files also had the final histopathological examination and composed this study sample. The study sample comprised individuals aged from 15 to 75 years, of both genders. All CBCT images were acquired through i-CAT Next Generation scanner (Imaging Sciences International, Hatfield, PA, USA), at the Radiology Clinics of the institution. The acquisition protocol was: 0.25 mm voxel and 16 x 13 cm field of vision (FOV), covering both arches and face.

All CBCT images were evaluated through i-CAT Vision software, at multi-planar reconstruction (MPR) which simultaneously exhibits the coronal, axial, and sagittal cuts of the area. If suitable, we allowed the reformatting of the panoramic curve tracing and consequently obtained the cross-sectional cuts. All analyses were performed by a single radiologist with more than five years of expertise in CT, previously trained to observe the total acquired FOV, with emphasis on the pathologic findings, but blinded regarding the clinical and histopathological characteristics of each lesion. This examiner described the osseous lesions based on the criteria seen in Chart 1, which are routinely used by radiologists to write imaging reports [8]. Figures 1 to 3 show some examples of lesions found in this study, based on the adopted criteria.

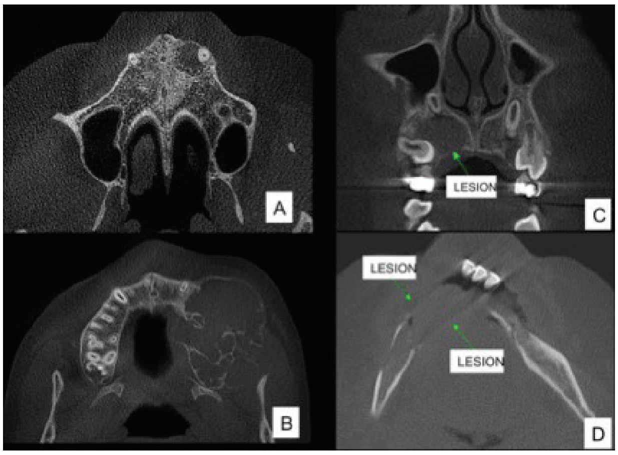

Figure 1 - CBCT axial cuts of maxilla evidencing: (A) lesion of unilocular aspect; (B) lesion of multilocular aspect. Coronal cut (C) evidencing a well-defined lesion. Axial cut showing a lesion with poorly defined limits (imprecise).

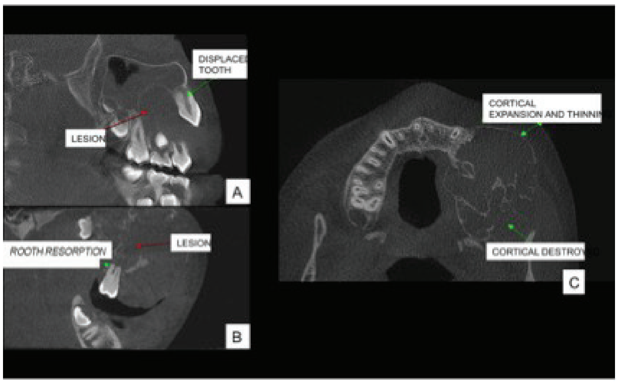

Figure 2 - CBCT coronal cuts exhibiting: (A) hypodense lesion; (B) hyperdense lesion and (C) mixed lesion.

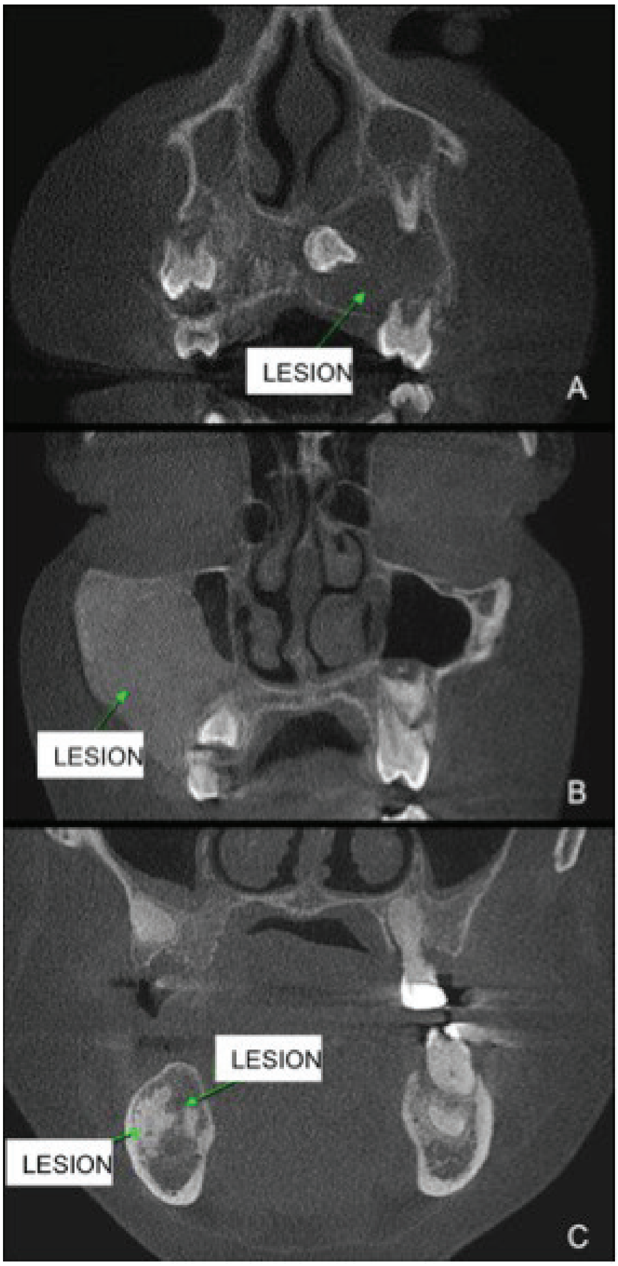

Figure 3 - CBCT sagittal cuts evidencing: (A) tooth expulsion due to the lesion; (B) External root resorption. (C) Axial cut exemplifying a lesion with bulging, thinning, and discontinuity of the corticals.

Chart 1 - CBCT analysis criteria regarding visual aspects.

Location	Unifocal	Only on one area of the arch or facial bone
	Multifocal	On many areas of the arch or facial bone
Shape	Unilocular	Single internal locus.
	Multilocular	Many loci with septa.
	Scalloped	Curve edges, following the tooth roots.
Contour	Well-defined	Precise limits between the lesion and the surrounding bone tissue, with or without corticals.
	Imprecise	Imprecise limits between the lesion and surrounding bone.
Internal Content	Hypodense	Totally hypodense lesion
	Hyperdense	Totally hyperdense lesion
	Mixed	Presence of hyperdense tissue inside the hypodense lesion.
Effect on teeth	Expulsion	Expulsion from the normal site
	Resorptions	External root resorption
Effect on bone corticals	No effect	Normal cortical aspect
	Bulging	Cortical expansion
	Thinning	Thinning of the cortical thickness
	Discontinuity	Presence of cortical discontinuity

All data were tabulated regarding to the clinical (age, gender, signs and symptoms) and CBCT imaging characteristics and submitted to descriptive analysis to compare with the literature findings.

RESULTS

The study sample results (cases 1 to 12) regarding to gender, age range, and main complaint are seen in Table I.

Table II evidences the characteristics of each alteration on CBCT images taking into account the analyzed parameters.

Table I - Sample distribution regarding gender, age range, and main complaint.

Case	Gender	Age range	Main complaint
#1	Male	4th decade (38 years)	Seed in mouth
#2	Female	3rd decade (22 years)	Incidental radiographic finding
#3	Male	5th decade (48 years)	Referral
#4	Male	2nd decade (10 years)	Referral by the Orthodontist
#5	Male	2nd decade (16 years)	Radiographic alteration
#6	Female	8th decade (71 years)	Pain in lower teeth area
#7	Female	4th decade (31 years)	Palate swelling
#8	Male	4th decade (31 years)	Cyst in anterior gingiva
#9	Female	3rd decade (28 years)	Cyst in palate
#10	Female	5th decade (47 years)	Pain during mouth opening and closure
#11	Female	5th decade (47 years)	Swelling in gingiva with suppuration
#12	Female	6th decade (56 years)	Referral for orthodontic documentation – incidental finding

Table II - Characteristics of the structures acquired in CBCT images in relation to location, shape, and contour.

Case	Location	Shape	Contour	Content	Effect on corticals/ structures
#1	Left Mandibular body	unilocular	Well defined	Hypodense	B, THNG,D
#2	Anterior mandible	unilocular	Well defined	Hyperdense	Cortical B
#3	Maxilla	unilocular	Well defined	Hypodense	Cortical B
#4	Anterior Maxilla	unilocular	Well defined	Hypodense	Exp of structures
#5	Right Mandibular body	multilocular	Imprecise	Mixed	Exp of structures
#6	Anterior Maxilla	unilocular	Well defined	Hypodense	Without effects
#7	Anterior Maxilla	unilocular	Well defined	Hypodense	Exp of structures
#8	Anterior Maxilla	multilocular	Well defined	Mixed	Cortical B
#9	Periapex – posterior maxilla	unilocular	Well defined	Hypodense	Without effects
#10	Right Mandibular body	unilocular	Imprecise	Hyperdense	B
#11	Posterior maxilla	unilocular	Well defined	Hypodense	Without effects
#12	Retromolar trigone	multilocular	Well defined	Mixed	B

* B Ō Bulging; THNG Ō Thinning; Exp Ō Expulsion; D Ō Discontinuity

Table III exhibits the results of the histopathological examinations regarding to each studied alteration.

Table III - Histopathological diagnosis of each alteration

Case	Effect on corticals / structures
#1	Odontogenic cyst
#2	Compound Odontoma
#3	Radicular cyst
#4	Hamartoma of pericoronal area
#5	Calcifying cystic odontogenic tumor
#6	Fibrous scar
#7	Periapical cyst
#8	Keratocystic odontogenic tumor
#9	Fibrous scar
#10	Focal osseous dysplasia
#11	Periapical cyst
#12	Keratocystic odontogenic tumor

DISCUSSION

The use of three-dimensional images for diagnosing and treatment planning of maxillofacial alterations progressively increased at the last decade of dental practice. CBCT greatly accounts for this increasing by approaching the dentists with CT imaging. CBCT imaging for the study on maxillofacial pathologic lesions is greatly valuable because it enables the characterization of the lesion behavior, which was limited in conventional radiographs due to the two-dimensional acquisition of the structures. Based on this, this study evaluated the behavior of different lesions though CBCT, characterizing the images according to the location, site, contour, content, and effects on bone corticals and surrounding structures. We associated the CBCT imaging aspects with the histopathological aspect of each case to enable the analysis of the lesions regarding to the clinical and imaging characteristics, emphasizing possible differences between CBCT and radiographic findings reported by the literature.

We found four cases of radicular odontogenic cysts and two cases of fibrous scars that can be originated from previous odontogenic lesions. Of the total, only one case (#10) did not have odontogenic origin (Focal osseous dysplasia). This result occurred because we focused on the maxillofacial arches, which are sites of odontogenic tissues with capacity of developing these lesions.

In this study, radicular cysts were the most prevalent lesions, corroborating the reports of the lesions most affecting the dental arches together with the odontogenic tumors – especially the keratocystic odontogenic tumor – a tumor with high prevalence. Didactically speaking, we individually addressed each lesion according to the histopathologic diagnosis and compared this with the reports of the literature to observe the described lesion pattern.

Odontogenic cysts

Four cases (#1, #3, #7, and #11) were histopathologically diagnosed as radicular cysts: three cases in the maxilla and one case in the mandible, with well delimited limits, unilocular and hypodense aspect, corroborating some authors in the literature [7-9]. In this study, the odontogenic cysts caused expulsion of the structures, cortical bulging and discontinuity, which are typical effects of benign lesions of slow and expansive growth, as radicular cysts. By observing Table I, we noted that the main complaints of these cases did not report pain symptomatology probably because the chronic path of these pathologies, leading to greater probability of effects on surrounding structures. Only one case did not showed alterations on corticals or surrounding structures, which could be explained by the greater dimension or time of occurrence of this lesion.

Keratocystic odontogenic tumors

This study histologically identified two keratocystic odontogenic tumors (KOT) (cases #8 and #12) in one male and one female. One case (#12) located in the posterior region of the mandible (retromolar trigone), which is in agreement with the literature that affirms that most of this lesion type affects the mandibular trigone and ramus [10-13]. The other case (#8) located in the anterior region of the maxilla, which is a more uncommon are for the occurrence of this lesion. Only one study [14] reports the occurrence of keratocystic odontogenic tumor in maxilla, characterizing this finding as rare and associated with the ectopic position of a tooth.

Both KOT were multilocular and with precise limits. The literature report that KOT shows great pleomorphism, exhibiting a unilocular or multilocular aspect, but always with precise limits [9], as found in this present study. We emphasize the mixed aspect of these lesions, found in both cases of this study. Generally, the literature reports [8,9] that KOT shows hypodense aspects even with an internal marked keratinization degree, inherent to this pathology, their density pattern does not alter. The presence of possible associated calcifications with probable dystrophic character should be investigated in the KOT lesions of this present study.

Other important observation is the cortical bulging caused by KOT in this present study. Normally, KOT does not cause cortical bulging because it grows among the marrow spaces. However, both lesions had greater dimensions which would account for this bulging. Other explanation would be the location of one of the cases – the maxilla – which has a thin alveolar bone that could enable the cortical bulging.

Compound odontoma

One case (#2) was diagnosed as compound odontoma. This lesion is considered by some authors [8-10] as a possible hamartoma and is classified by the World Health Organization (WHO, 2005) as a benign tumor of odontogenic epithelium and odontogenic ectomesenchyme [11]. The compound odontoma normally shows a typical imaging characteristic because is composed by dysmorphic teeth located more frequently in anterior maxilla [8-11]. However, in this study, the compound odontoma was located in anterior mandible and caused cortical bulging, which disagrees with the literature.

A retrospective study on 69 cases of odontoma types (compound and complex) [15] found that only 49 were compound and located in anterior maxilla. This study reported that cortical bulging caused by compound odontomas is rare, only occurring associated with tooth retention due to the tooth volume itself, impacted by the tumor mass. This corroborates this present study because an impacted tooth was associated with the compound odontoma, and incidentally found (Table I), during the search for the cause of the non-irruption of the tooth. We emphasized that case #4, histologically diagnosed as Odontogenic Hamartoma, could have been classified as Odontoma by the CBCT image.

Calcifying cystic odontogenic tumor

We found one case (#5) of calcifying cystic odontogenic tumor (CCOT). CCOT is previously defined [16] as benign odontogenic neoplasia, characterized by the presence of epithelial tissue similar to ameloblasts with the presence of the so-called phantom cells and it could show calcifications, among which the odontoma – observed in this present study. The literature [16] reports that type 2 CCOT – associated with odontoma – most frequently affects the mandible (73% of the cases), as observed by this study (Table II).

It is important noting that the literature emphasizes that CCOT has a unilocular aspect in 92% of the cases, differently from the CBCT image observed in this present study which CCOT showed a multilocular aspect. However, this study [16] does not cite the CBCT for characterizing this lesion, leading us to conclude that the conventional radiograph may have provided mistaken data regarding the predominant unilocular aspect of the lesion. This justifies the CBCT use for studying lesions of greater dimensions in the maxillofacial complex. In this study, CCOT caused the bulging of the surrounding structures, corroborating other descriptive study with CBCT images [17].

Focal Osseous Dysplasia

One case (#10) was histologically diagnosed as focal osseous dysplasia. In this present study, all characteristics met those described in the literature regarding the affected area (mandibular molars) [18,19] and presence of hyperdense areas inside the lesion. We highlight that the volumetric study through CBCT, in this present research, made possible to identify the bulging of the surrounding corticals, which is not frequently reported by the literature. One possible explanation for this difference could be that most of the studies used conventional radiographs, especially panoramic and periapical radiographs, making the evaluation impossible.

Fibrous scar

Two cases (cases #6 and #9) were histologically diagnosed as fibrous scar. Fibrous scar can appear with many different aspects on CBCT with hypodense content which could have been diagnosed as osteolytic, cystic, or neoplastic lesion. This finding is important because emphasizes the inherent limitation of CBCT: impossibility identification of the content nature of the soft tissues inside the lesions. Accordingly, CBCT is an excellent method for alterations in calcified tissues, but it provides information on these tissues. Muscle or gland alterations tend to be identified only at stages compromising the underlying bone tissues, but without a characterization of the biological alteration of the soft tissue. Thus, considering this limitation, other techniques should be executed rather than CBCT, for example: magnetic resonance imaging, ultrasound, or FBCT.

Final considerations

We emphasize that the classical characterization of the lesions described in the literature and mostly based on conventional two-dimensional images (radiographs) accounted for the divergence of the CBCT findings of this presence study from those of the literature. This fact highlights the importance of reestablishing and reporting new criteria for characterizing maxillofacial lesions, taking into account volumetric examinations as CBCT, justifying the importance of this present study.

CONCLUSION

Some imaging characteristics of the maxillofacial bone lesions addressed in the literature differed from those in this present study, which can be explained by the frequent use of conventional radiographic images in most of the studies on the literature, making impossible the most detailed analysis of the lesions. CBCT images are valuable for characterizing maxillofacial osseous lesions, mainly in relation to the effects on the corticals, location, and surrounding structures.

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