Importance of interpreting the cone beam computed tomography obtained volume: incidental findings of a private radiological service

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Objective: To evaluate whether the images obtained outside the area of interest requested by the dentist are important and would modify the treatment plan, aiming to establish the occurrence of incidental findings in all areas of exams requested for evaluation of only one region. **Methods:** images of 100 cone beam computed tomography exams, requested for different purposes, were randomly selected from a private practice images database. All images were obtained in an i-CAT Classic Cone Beam 3-D Imaging System® CT scanner, with FOV ranging from 6cm for maxilla or mandible to 8cm for maxilla and mandible, according to the indication and each patient skull anatomy. The voxel size varied between 0.20mm and 0.25mm. All the image volume was evaluated at all reconstruction, by a single examiner. **Results:** incidental findings were found in 82 of the 100 evaluated images, totaling 185 findings. The mean age of subjects was 48 years and 4 months, and the female sex was predominant. **Conclusions:** The results, presented in a descriptive statistical way, showed a high number of incidental findings, especially in the regions of the teeth and maxillary sinus. **Keywords:** Incidental findings. Diagnosis. Cone-beam computed tomography.

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INTRODUCTION

Cone-beam computed tomography (CBCT) is a complementary exam that has been established in dentistry as an aid to diagnosis, since it allows detail richness, sharpness, accuracy, real-size reproduction, reduction in the number of artifacts, multiplanar and 3D reconstructions.[1,2,3] The decision to expose the patient to ionizing radiation is only justified when the chosen method provides diagnostic information.[4,5] Thus, CBCT has been indicated for retained teeth evaluation, alveolar bone thickness evaluation, temporomandibular joint (TMJ) visualization, air space assessment, root resorptions identification, preoperative evaluation, cephalometric analysis and bone structures thickness evaluation, especially in the lip and palate clefts region.[6,7,8,9,10,11]

The X-ray beam collimation is one of the factors used in radioprotection by limiting exposure to radiation. Currently, there are CBCT equipment with varying FOV (field of view) sizes, which allows the dental surgeon to specify the area of interest for evaluation. Small and medium FOV allow the acquisition of an arch image or even a region. The large FOV enables image acquisition of the whole skull or maxilla and/or mandible.

The choice for a specific area/region does not decrease the radiation dose and allows the visualization of areas that extend beyond the region of interest. If a dentist requests a "21-tooth area tomography scan" in order to reduce costs or the radiation dose to the patient, it will be necessary to select FOV for the entire maxilla and, inevitably, a view of all teeth, bone structures and adjacent structures, which should be evaluated because abnormalities can be found.

In this paper, we proposed to evaluate if the images obtained outside the area of interest requested by the dentist are important and would modify the treatment plan. We intend to establish the occurrence of the changes found in all areas in exams that are requested to evaluate a region only.

METHODOLOGY

We used images from 100 individuals submitted to CBCT, requested for different reasons, randomly selected from the database of a private clinic.

All images were obtained in a i-Cat Classic Cone Beam 3-D Imaging System (USA) model tomograph, with FOV ranging from 6cm for maxilla or mandible to 8cm maxilla and mandible, according to the indication and anatomy of each patient skull. The voxel ranged from 0.25mm to 0.20mm. The entire volume in the image was evaluated in all the reformattings by a single examiner, radiologist, with experience in the interpretation of tomographic images, using the I-CAT Vision software and, during visualization, adjustments were made for brightness, contrast, sharpness and zoom. When necessary, angulation of the planes was performed, providing a complete analysis. No further examination was used.

Images with artifacts that prevented interpretation were excluded. For this research, we did not evaluate: dental absences, caries, horizontal/vertical bone loss and presence of salivary calculi. After the exams selection, the patient's gender and age, requested region, reason for the exam (when described), voxel and found incidental findings were registered. Were considered as incidental findings all who are not part of the anatomical and natural conditions of the maxillomandibular complex, such as: periapical lesions, bone rarefaction, higher bone density areas, cysts, tumors, dental anomalies, soft tissue calcifications, among others.

The results were presented in a descriptive statistical manner and divided into:

I - cases requiring intervention;

II - cases requiring follow-up; and

III - cases that do not require intervention or follow-up.

In order to organize the analysis, we divide the regions into zones:

Zone 1 - Airways and nasal fossa;

Zone 2 - TMJ;

Zone 3 - Maxilla and mandible bone evaluation;

Zone 4 - Jaw injuries;

Zone 5 - Dental changes; and

Zone 6 - Soft tissue evaluation.

RESULTS

Of the 100 images evaluated, 82 presented an incidental finding, totaling 184 findings. The mean age of the subjects was 48 years and 4 months and the predominance was female (Table 1).

The Images were acquired: maxilla (63), mandible (33), maxilla and mandible (4). Of the patients, 51 reported the examination reason: implant placement evaluation (80.3%), assessment of non-erupted teeth (7.8%), root fracture evaluation (7.8%), graft evaluation (1.9%) and maxillofacial complex lesions evaluation (1.9%) (Table 2).

The Kappa test was used to assess the intra-examiner agreement in the 6 zones over a period of 15 days. The result of excellent agreement was obtained (Table 3).

The prevalence of incidental findings was: zone 5 (99), zone 1 (44), zone 6 (21), zone 2 (10), zone 3 (10) and zone 4 (1) (Table 4). 54 need intervention (I), 24 need follow-up (II) and 106 do not require intervention or follow-up (III) (Table 5).

Table 1: Profile of patients submitted to CBCT scan in the sample regarding gender and age.

GENDER	AVERAGE AGE	NUMBER OF EXAMS(%)
Male	45y and 4m	40 (40%)
Female	50y and 4m	60 (60%)
Total	48y and 4m	100 (100%)

Table 2: Rationale for carrying out the CBCT exams of the sample according to the requisition form.

REASON FOR THE EXAMINATIONS	NUMBER	%
Implant installation	41	80,3922%
Non-erupted teeth	4	7,8431%
Root fracture	4	7,8431%
Graft evaluation	1	1,9608%
Pathological areas	1	1,9608%
Total	51	100%

Table 3: Kappa Test Result for each analyzed region.

ASSESSED ZONE	KAPPA RESULT
Zone 1	0,88
Zone 2	0,86
Zone 3	1,0
Zone 4	0,98
Zone 5	0,81
Zone 6	0,95

Table 4: Required medical/dental intervention of the incidental findings found, by zone.

ZONE	NEED INTERVENTION (I)	NEED FOLLOW-UP (II)	DO NOT REQUIRE INTERVENTION OR FOLLOW-UP (III)
Zone 1	0	0	44
Zone 2	0	0	10
Zone 3	1	1	8
Zone 4	1	0	0
Zone 5	52	23	24
Zone 6	1	0	20
Total	55	24	106

Table 5: Description of the incidental findings found in the sample, by evaluated zone.

ZONE	NUMBER OF ASSESSED EXAMS	NUMBER OF INCIDENTAL FINDINGS	INCIDENTAL FINDINGS DESCRIPTION
Zone 1	34	44	Unilateral thickening (16); bilateral thick-ening (12); septal deviation (8); mucous cyst (6); anthropoid (1); bullous shell (1)
Zone 2	25	10	Unilateral planing (1); bilateral planing (2); unilateral osteophyte (2); bilateral osteophyte (5)
Zone 3	100	10	Osteosclerosis (7); condensing osteite (1); torus (1)
Zone 4	100	1	Odontoma (1) osseous cement florid dysplasia (1)
Zone 5	100	99	Apical injury (34); external root resorption / remodeling (14); dilaceration (8); apical material excess (7); endoperiodontal injury (6); furca injury (6); retained tooth (5); apical periodontal space enlargement (4); gyro version (3); crack / fracture (2); pulp calcification (2); residual root (1); implant fenestration (1); amalgam fragment (1); supernumerary tooth (1); internal resorption (1); microdontia (1); odontoma (1); supernumerary cusp (1)
Zone 6	100	21	Styloid process unilateral elongation (10); bilateral elongation (6); tonsilolite (2); atheroma (1); triticea calcification (1); sialolite (1)

DISCUSSION

The importance of the images total volume interpretation was based: of the 100 exams, only 8% (18) of the images did not present incidental findings and 92% (82) presented incidental findings; in several exams, incidental findings have been observed in more than one zone. This value is very similar to that found in other studies, which presented 94.3%, 90.7% and 93.4%.[12,13,14]

In a study of 329 CBCT required for orthodontic evaluation, at least 1 incidental finding was found per individual, with a higher frequency of dental origin, corroborating the present study.[15]

Different authors also presented mean age above the fourth decade of life, a higher female prevalence and a greater number of implant-related requests.[16,17] The images used belonged to Brazilians and were obtained in a private clinic: it is an indicator of the profile of these individuals and may differ from the results of surveys that use samples obtained in universities regarding socioeconomic profile and location. We know that the socioeconomic level can directly influence oral health and, therefore, present results different from those found in our study.[18]

It is scarce the number of papers published with Brazilian sample and future studies should be carried out for comparison.

The incidental findings were divided according to the studied zone:

Airways (zone 1)

We considered images larger than 3.00mm as thickening of the mucosa,[19] often related to odontogenic origin sinusitis by proximity to the posterior teeth dental apices.[13,20,21]

None of the mucosal thickening findings required follow-up. However, we emphasize the importance of considering the relationship of mucosal thickening with teeth, since periapical lesion is a potential source for the propagation of maxillary sinuses reactions.[22,23,24]

Eight (8) images compatible with mucosal retention pseudocysts have been described, which rarely present signs and symptoms, are self-limiting and are not related to periapical lesions.[19,25] In similar studies, it is difficult to obtain clinical information, a frequent failure of the dental surgeon requesting the image, and we rely only on the information obtained from the radiographic image. When the patient presents related symptomatology, it is suggested the evaluation by otorhinolaryngologist.

We observed one (1) image with the presence of a bullous shell and did not deem necessary monitoring or intervention. There is a strong association between the presence of bullous shell and the contralateral deviation of the nasal septum and the intervention is indicated in case of extensive bullous shell associated to the symptomatology.[26]

A single case presented anthropoid associated with mucosa thickening. In other studies that verified the presence of anthropoids, these had a relationship with sinusopathies.[13,27]

TMJ (zone 2)

We evaluated planing, osteophytes, erosion, subchondral cyst and other changes in the mandible head, which may be associated with degenerative diseases.

The images obtained by CBCT have shown to be effective where there is suspicion of degenerative bone alterations and complementary evaluation in cases of trauma, ankyloses and tumors[28,29].

Of the 25 cases in which it was possible to evaluate the condyles, 40% presented alterations: planing and osteophyte / degenerative disease. All changes show signs of remodeling, evidenced by planing.[30]

The mean age of this study allows us to observe a greater tendency for remodeling, since degenerative diseases occur in older patients.[31]

There are restrictions for assessment of soft structures in CBCT (joint disc, ligaments and related musculature). In these cases, the magnetic resonance imaging (MRI) exam presents more effective and detailed results.

Bone structures (zone 3)

Many doubts in the interpretation of the conventional or tomographic images are related to the maxillary bones. In this study, the bone findings represented 10% of the total and the most common was bone sclerosis, of little clinical relevance and no need to intercede.

One (1) case of palatine torus was found, exostosis caused by genetic evidence and environmental factors,[32] without the need for follow-up. It was observed one (1) case of condensing osteitis, when there is pulp involvement, requiring intervention because it is a response of the bone tissue to endodontic or periodontal bacterial stimuli.[33,34] We identified one (1) image compatible with florid bone dysplasia and considered follow-up by susceptibility to infections with the advancement of the years.[35,36]

Jaw injuries (zone 4)

We observed one (1) case of odontoma associated with permanent non-erupted second molar. Surgical removal is recommended.[37,38] Incidental findings investigations reveal that the incidence of cysts or tumors is low, around 2%.[12,39] No cases of cyst were found in our sample.

Dental changes (zone 5)

It was the region with the greatest number of findings. Pulp alterations were uncommon and considered of little clinical relevance. The apical lesions were the most prevalent and were related to endodontic problems. The rupture of the hard blade and the hypodensity in the apical region are considered parameters that confirm the presence of periapex lesions.[40]

Based on these parameters, we found 98 images with periapex lesions. These images were classified as images that require intervention and / or follow-up due to the absence of the medical history, which is not part of the research objective, although of great use to radiologists.

Only four (4) cases presented enlargement of the apical periodontal space and it was considered a need for intervention. Clinical examination done by the dentist would certainly be decisive in the diagnosis and treatment plan. Endo-periodontal lesions were considered when it was possible to detect a hypodense area in the apical region or in the support structure. When these lesions fuse, it is considered a bone defect, resulting in loss of insertion and alveolar bone destruction.[41,42] Six (6) cases of endoperiodontal lesion and six (6) cases of furca lesion were found, where intervention is necessary in order to avoid injury progression. We found a root fracture in three (3) cases, all located in anterior teeth, as found in the literature.[13,43,44]

Dental anomalies, 10 cases (9.8%), are common findings in dental radiology, however, dilaceration, supernumerary cusp and microdontia were not relevant findings. However, dental anomalies related to retained teeth, third molars, may require intervention, depending on location and relationship with adjacent teeth.[45]

The only case of a supernumerary tooth, inverted, was found in the incisor region and, in the sagittal reconstruction, it was possible to visualize the position of the apex for palatine and presence of internal radicular resorption, requiring surgical intervention.

When the image of the apical portion of the teeth presented with bulging or remodeling,[46,47] we consider external resorption / remodeling, observed in 14 cases. This remodeling may be multifactorial, more commonly associated with trauma or the use of orthodontic appliance. They were observed in the upper and lower incisors.[48] Internal resorption was observed in a lower premolar.

In the case of implant fenestration, the inclined vestibular implant was noted, with absence of vestibular bone support, which could compromise its stability and function.[49]

Soft tissue / Calcifications (zone 6)

The number of incidental findings in the oropharynx region was 21 (19%): unilateral or bilateral styloid process elongation (16), tonsilolite (2), atheroma (1), tritike cartilage calcification (1) and sialolite (1), similar to those described by Price et al, 2012. Tonsiloliths are commonly found in radiographic examinations of the head and neck region, usually asymptomatic[50] and, when symptomatic, include symptoms such as: halitosis, cough, foreign body sensation or dysphagia.[51,52]

The styloid process elongation or calcification does not require intervention as long as the patients do not report symptomatology. When symptomatic, it may be related to Eagle Syndrome.[53,54,55]

One (1) case of atheroma was diagnosed in a 70-year-old man. Atheroma is more frequent in adult patients and may be an indicator of potential for stroke.[56] The dentist can identify and prevent the patient.[54]

A sialolite compatible image was observed. Often, the patient presents symptomatology, with a history of intermittent pain and swelling.[57]

Soft tissue calcifications or ossifications are not always easy to interpret and the radiologist should be calibrated for possible differential diagnoses, based on the findings location, distribution, and morphology.

The large number of incidental findings obtained in this study shows the importance of a thorough evaluation of all the zones present in the volume, even in poorly relevant clinical diagnoses. All the exams evaluated were lauded throughout their volume and made available by the private clinic. In addition to the radiologist, the dental surgeon must evaluate the entire image obtained, regardless of the purpose of the examination; because the same may come across findings of great relevance, which may generate legal problems when not communicated to the patient.

Some examples of incidental findings can be seen in Figures 1, 2, 3, 4, 5, 6, 7, 8 and 9, marked on the images with the red arrow.

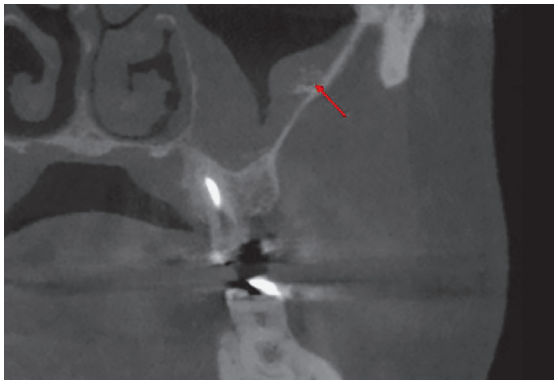

Figure 1: Coronal plane: thickening of the bilateral sinus mucosa and presence of anthropoie on the left side.

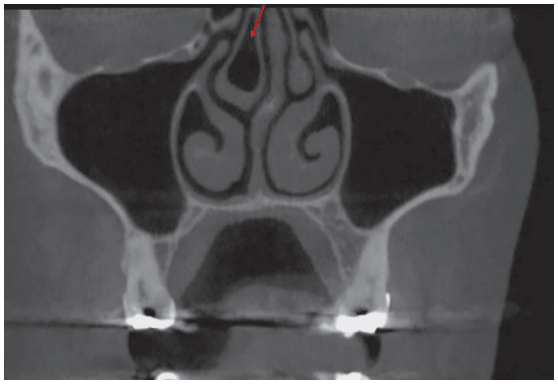

Figure 2: Coronal Plane: presence of bullous shell on the right side.

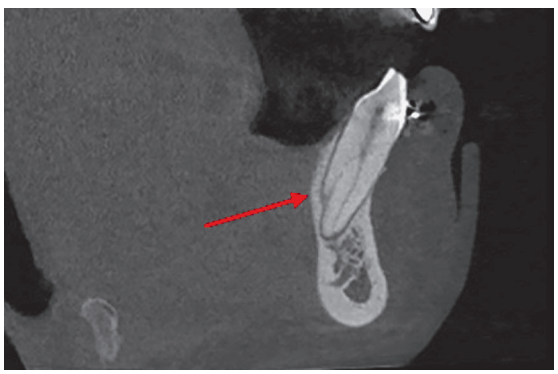

Figure 3: Sagittal Plane: supernumerary cusp in right lower canine.

Figure 4: Sagittal Plane: retained tooth, mesioangulated and in intimate contact with the distal root of the 47 tooth.

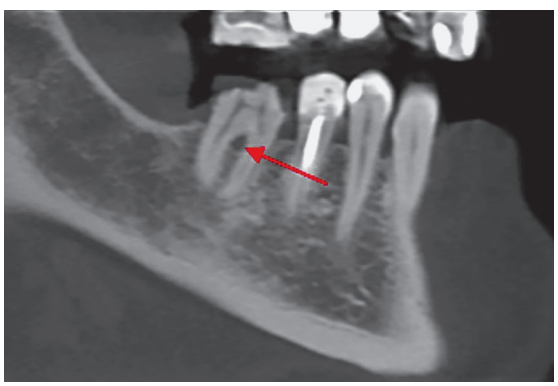

Figure 5: Sagittal Plane: furca injury.

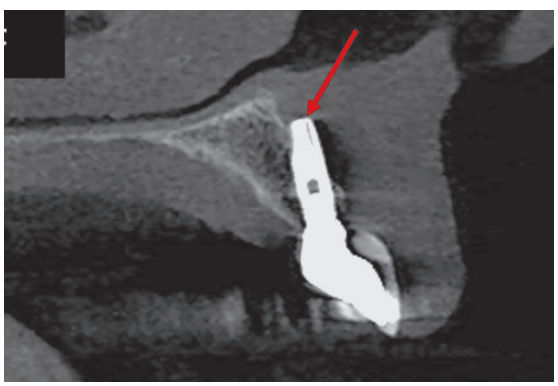

Figure 6: Sagittal Plane: implant fenestration.

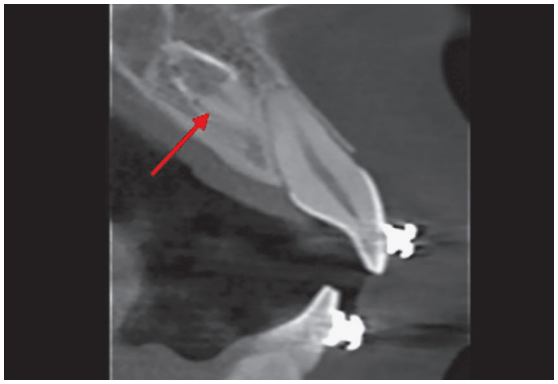

Figure 7: Sagittal Plane: supernumerary tooth, inverted and with internal resorption.

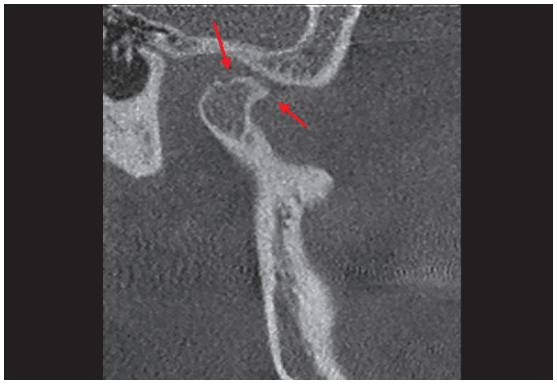

Figure 8: Sagittal Plane: osteophyte and superior erosion of the mandible head.

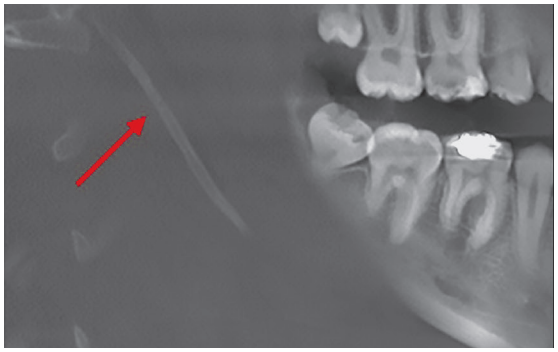

Figure 9: Sagittal Plane: styloid process elongation.

CONCLUSION

The results showed a high number of incidental findings, especially in the teeth and maxillary sinus regions. The study shows the importance of the knowledge of the radiographic anatomy and the evaluation of the whole volume of the examination.

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