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Original Research

Comparision of diagnostic accuracy of intraosseous jaw lesions via CBCT & 3DCT: An original research

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ABSTRACT:
Introduction: In the present study we aim to compare the diagnostic accuracy of intraosseous jaw lesions via CBCT & 3DCT. **Material and Methods:** 225 sets of 3DCT and CBCT images with biopsy-proven histopathological diagnoses were retrospectively compared in terms of radiographic features and diagnostic accuracy. The imaging characteristics of 3DCT and CBCT were independently evaluated by two oral and maxillofacial radiologists who were required to answer 12 questions and provided up to three differential diagnoses with their confidence scores. **Results:** Odds ratios (ORs) were statistically significant for border cortication (OR = 1.521; p = .003) and border continuity (OR = 0.421; p = .001), involvement on neurovascular canals (OR = 2.424; p < .001), ex3DCTsion (OR = 7.948; p < .001), cortical thinning (OR = 20.480; p < .001) as well as its destruction (OR = 25.022; p < .001) and root resorption (OR = 2.477; p < .001). Furthermore, imaging features in the posterior and mandibular regions showed better agreement than those in the anterior and maxillary regions, respectively. The diagnostic accu- racy of the first differential diagnosis was higher on CBCT than on 3DCT (Observer 1:78.7 *vs* 64.4%; Observer 2: 78.7 *vs* 70.2% (p < .001)). The observers' confidence scores were also higher at CBCT interpretation compared with 3DCT. **Conclusions:** CBCT demonstrated a greater number of imaging characteristics of intraosseous jaw lesions compared with 3DCT, especially in the anterior regions of both jaws and in the maxilla.
Keywords: Radiographic characteristics; Intra-osseous jaw lesion; 3DCT; CBCT.

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INTRODUCTION

3DCToramic radiography (3DCT) and cone beam computed tomography (CBCT) are two radiographical modalities used in the diagnosis and treatment planning and management of oral and maxillofacial diseases. Not only do they show the imaging features of lesions, but they also guide the clinicians to make the most appropriate diagnoses as well as the

subsequent treatment plans, and to monitor healing and/or the disease recurrence during follow up.

CBCT, which has been widely introduced in maxillofacial imaging since late 1990s, has advantages over the two-dimensional CT, due to its three-dimensional nature.2,3 CBCT is prone to various artefacts, especially metal and motion artefacts, which can have a deleterious effect on the image quality.1,4,5 Compared with spiral CT, its contrast resolution is lower and soft tissues are poorly demonstrated.5 Compared with 3DCT, the effective radiation dose of CBCT is usually significantly higher and this should be taken into consideration when imaging is required.7

It is well known that CBCT has many advantages in the diagnosis of oral and maxillofacial diseases.8–11 Compared with 3DCT, CBCT can provide more information to aid clinicians in making diagnoses, designing treatment plans, and monitoring follow-ups postoperatively. Currently, there is a paucity of studies focusing on the differences of radiographical characteristics between 3DCT and CBCT for imaging the intraosseous jaw lesions in a quantitative method. Therefore, in the present study we aim to compare the diagnostic accuracy of intraosseous jaw lesions via CBCT & 3DCT.

METHODS AND MATERIALS

We conducted a retrospective study. 225 cases containing both 3DCT and CBCT data were included. Inclusion criteria: 1) Patients with intraosseous lesions of the maxilla and/ or mandible, including recurrent and multiple lesions; 2) 3DCT and CBCT examinations with a time interval of no more than 3 months; and 3) with definitive histopathological diagnoses. Exclusion criteria: 1) Soft tissue lesions in the oral and maxillofacial region; 2) incomplete imaging data (*i.e.,* either 3DCT or CBCT images were not available); 3) histopathological diagnoses were not definitive; 4) image quality of 3DCT or CBCT were not satisfactory, for example, poor imaging quality due to artefacts, or the region of interest not fully included; and 5) surgical treatment was performed during the interval between the examination of 3DCT and CBCT.

Two oral and maxillofacial radiologists, both with 5 years of experience, interpreted the 3DCT images and CBCT images separately. After reviewing every image, the observers were asked to complete 13 including imaging features and differential diagnoses. After a "wash-out" period of at least 1 month, 20 sets of 3DCT and CBCT images were randomly selected to examine intraobserver reliability. Simple statistics were also used to compare the agreement in different regions of jaws.

RESULTS

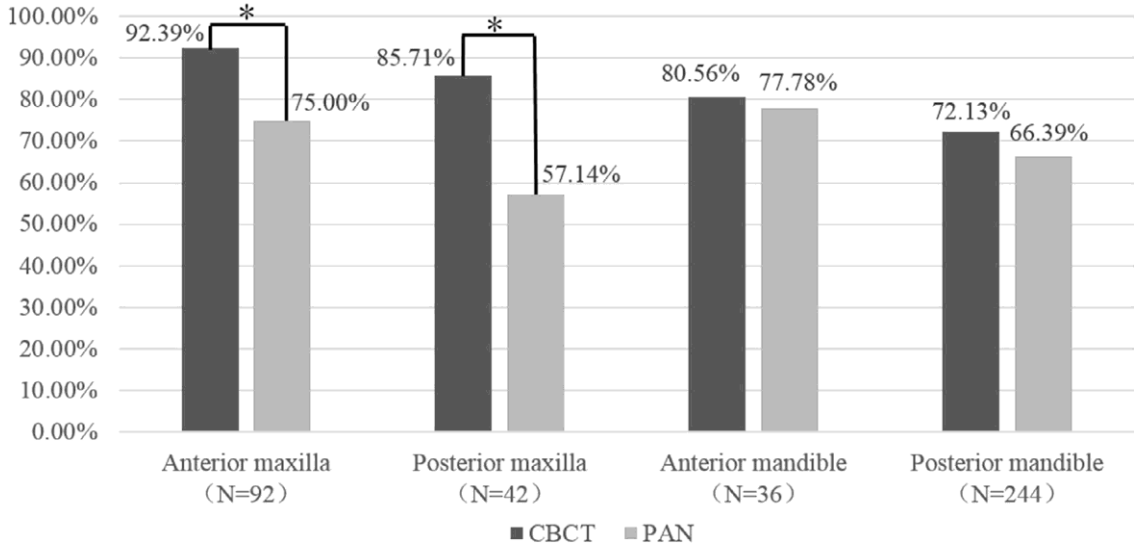
Odds ratios (ORs) were statistically significant for border cortication (OR = 1.521; p = .003) and border continuity (OR = 0.421; p = .001), involvement on neurovascular canals (OR = 2.424; p < .001), ex3DCTsion (OR = 7.948; p < .001), cortical thinning (OR = 20.480; p< .001) as well as its destruction (OR = 25.022; p < .001) and root resorption (OR = 2.477; p < .001). Furthermore, imaging features in the posterior and mandibular regions showed better agreement than those in the anterior and maxillary regions, respectively. The diagnostic accu- racy of the first differential diagnosis was higher on CBCT than on 3DCT (Observer 1:78.7 *vs* 64.4%; Observer 2: 78.7 *vs* 70.2% (p < .001)). The observers' confidence scores were also higher at CBCT interpretation compared with 3DCT. Table 1

These results were further analysed based on lesion location. The frequency of correct diagnoses made on the first attempt on CBCT were higher than on PAN across all locations (Figure 1). The accuracy of the first diagnosis on CBCT was much higher than that on PAN in the maxilla, both in the anterior and posterior regions ($p < 0.05$). In the mandible, CBCT had a slightly higher diagnostic accuracy than PAN both in the anterior and posterior regions, but this was not statistically significant ($p > 0.05$).

Table 1 Overall agreement between 3DCT and CBCT with respect to lesion features in different regions of jaws

	Questions	Anterior	Posterior	Maxilla	Mandible
1	What is the lesion's shape？	0.581	0.621	0.480	0.659
2	Are its borders well-defined？	0.495	0.740	0.491	0.791
3	Are its borders well-corticated in terms of thickness?	0.262	0.760	0.441	0.703
4	Are its borders continuously corticated?	0.300	0.113	0.177	0.157
5	The lesion's internal contents are mostly radiolucent/≤Soft tissue density, Mixed or Radiopaque/≥Bone density	0.710	0.637	0.654	0.631
6	Is the lesion multilocular?	0.062	0.453	0.268	0.481
7	Does it appear to be affecting the incisive canal or the inferior alveolar canal?	0.359	0.596	0.377	0.571
8	Does it appear to ex3DCTd the normal surrounding anatomic boundaries?	0.022	0.317	0.108	0.237
9	Does it appear to be causing cortical thinning?	0.012	0.119	0.043	0.086
10	Does it appear to be causing cortical destruction?	0.031	0.084	0.008	0.083
11	Does it appear to be causing tooth displacement?	0.649	0.740	0.648	0.740
12	Dose it appear to be causing root resorption?	0.379	0.398	0.325	0.449

Figure 1 Frequency of correct diagnosis at the first attempt on CBCT versus 3DCT at different locations in the jaws (*$p < 0.05$, indicated statistical significance).



DISCUSSION

In the evaluation of intraosseous jaw lesions, clinicians are mainly concerned about the location, size, shape and boundary of the lesions and the relationship with its associated surrounding structures. Our results have shown that significant differences are noted in the radiographical features of intraosseous lesions on CBCT compared to 3DCT, namely in lesion ex3DCTsion, cortical involvement, effect on the neurovascular canals and root resorption, especially in the anterior regions of both jaws and in the maxilla. Diagnostic accuracy and clinicians' confidence while evaluating CBCT have also been shown to be superior compared to 3DCT. These results could facilitate clinicians' decisions in choosing the appropriate imaging modalities during surgical planning or follow up.

IMAGING FEATURES ON 3DCT AND CBCT

Comparison of imaging features between 3DCT and CBCT in the present study was not fully in agreement with the most recent report from Lim et al, in terms of Q2 (border definition), Q4 (continuity of border cortication) and Q7 (effect on the incisive canal or IAC).12

In our results, substantial agreements between 3DCT and CBCT were shown in Q1 (lesion shape), Q2 (border definition), Q3 (border cortication), Q5

(internal contents) and Q11 (tooth displacement).

In describing lesion shape, although there was strong agreement in the lesion shape between 3DCT and CBCT, the present study also showed statistical difference between the two modalities. 330 of the total 450 cases were evaluated as the same shape types both on 3DCT and CBCT, of which 169 cases were evaluated as round or ovoid (usually seen in cysts) and 55 cases were evaluated as "cannot tell" (usually seen in osteomyelitis or malignant tumours), and this may contribute to the substantial agreement in the current study. 26.67% of the cases were evaluated as having different shapes on the two imaging modalities, for instance, round or ovoid on 3DCT, but scalloped or irregular on CBCT. One explanation for this could be that CBCT is able to display the morphology of lesions from different slices and various views.14 This is diagnostically important as different morphological characteristics often guide differential diagnoses. For example, round or oval shapes are more common in cysts, while lobular or irregular shape suggests the growth characteristics of the other lesions such as ameloblastoma.14–16

The result of Q2 (the border definition) in our study showed substantial agreement, while Lim et al reported only fair agreement.12 90.89% of the cases in this study were described to have the same border definition on 3DCT and CBCT. This might be attributed to the relatively large sample size and the type of pathology within the sample. The sample size of this study was 225 cases, of which cysts, benign tumours and tumour-like lesions accounted for nearly 80%, while this proportion in Lim's study was only 50% out of 31 cases.12 Most cysts and benign tumours manifest well-defined borders, and this is also a differentiating feature between benign and malignant diseases.17

In terms of the lesion's internal contents, substan- tial agreement was shown between 3DCT and CBCT, but there was still a statistical difference between the two methods. 81.78% of the cases were evaluated with the same internal densities, of which 61.11% cases were evaluated as radiolucent both on 3DCT and CBCT. The large proportion of cysts with radiolucency may contribute to the strong agreement. 18.22% of the cases were described as different internal densities between 3DCT and CBCT (*i.e.*, low density was indicated on 3DCT, while mixed or high density on CBCT and vice versa). Projection position, exposure condition and overlap- ping might contribute to inaccurate judgement on 3DCT, while CBCT could avoid this effectively by virtue of its three-dimensional nature and high spatial resolution.18

Poor agreement was shown in Q4 (continuity of border cortication), Q8 (ex3DCTsion of surrounding anatomic boundaries), Q9 (cortical thinning) and Q10 (cortical destruction) with significant ORs, respectively, which were consistent with Lim's results, except for the moderate agreement for Q4 in their study.12

In our study, continuity of the corticated borders was defined as a continuous dense line at the edges of the lesion. Some of the lesions showed clear and continuous corticated borders on 3DCT because of superimposition, but may appear to be discontinuous on consecutive CBCT images.11 Root resorption can be due to various etiologic factors including inflammation, adjacent impacted teeth, trauma and a variety of lesions, such as benign and malignant tumours and cysts. There was a statistically significant OR of 2.477 on root resorption between the two methods, and this finding was inconsistent with the most recent study by Lim et al, which had insufficient cases to demonstrate differences between 3DCT and CBCT for this radiographic feature.12

DIAGNOSTIC ACCURACY AND CLINICIANS' CONFIDENCE

Contrary to the results from Lim et al.'s study,12 our results showed that the accuracy of the first differen-tial diagnosis on CBCT was higher than that on 3DCT. CBCT could provide more comprehensive and detailed imaging information, which was helpful for making the diagnosis.8 Although diagnostic accuracy was closely related to the experience of doctors, the discre3DCTcy between the two studies is most likely attributed to the larger sample size in our study. CBCT was accurate in showing the characteristics of lesions, such as location, locularity, internal density, ex3DCTsion and its effect on the surrounding structures, which could help doctors to make a more accurate diagnosis. It was not surprising that the percentage of correct diagnoses on the first attempt was higher on CBCT than 3DCT in all regions of jaws, especially in the maxilla.

There was no unified and quantitative index for describing the imaging features of the lesions which was a limitation of our study.

CONCLUSIONS

The significant differences in the radiographic appearances of intraosseous lesions between 3DCT and CBCT were shown in the integrity of the corticated borders, expansion of surrounding anatomic boundaries, cortical thinning, cortical destruction and root resorption, especially in the anterior regions of both jaws and in the maxilla.

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