ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 6, Issue – 1, February - 2023, Page No. : 07 - 22

Diagnostic Accuracy of Panoramic Radiography Compared To CBCT: Impact on Radiographic Features and Differential Diagnosis

[1]Dr. Jaydeepa Basak, MDS, Consultant Dental Surgeon Sight and Smile Clinic, Newton, Kolkata, West Bengal

[2]Dr. Girish Katti, MDS, Principal and Dean, Navodaya Dental College, Raichur, Karnataka

[3]Dr. Syeda Arshiya Ara, Prof. & HOD, Albadar Dental College, Kalaburagi, Karnataka.

Corresponding Author: Dr. Jaydeepa Basak, MDS, Consultant Dental Surgeon Sight and Smile Clinic, Newton, Kolkata, West Bengal

Citation of this Article: Dr. Jaydeepa Basak, Dr. Girish Katti, Dr. Syeda Arshiya Ara, "Diagnostic Accuracy of Panoramic Radiography Compared To CBCT: Impact on Radiographic Features and Differential Diagnosis", IJDSIR-February - 2023, Volume – 6, Issue - 1, P. No. 07 – 22.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Intra-osseous pathologic lesions of the jaws represent wide range of radiographic features in Panoramic (PAN) radiography and Cone beam computed tomography (CBCT). The study was done to rule out diagnostic accuracy between CBCT and PAN.

Aim & Objectives: were to determine whether radiographic features of intraosseous jaw lesions appear differently on PAN and CBCT and to determine diagnostic accuracy between the two.

Materials and Methods: 30 sets of PAN and CBCT images with intraosseous jaw pathology were analyzed by two observers who were blind to each other and went through a series of questions with respect to the lesion features. The two observers provided two or three differential diagnosis as well as their confidence associated with each diagnosis based on the order of listing. The diagnostic accuracy was thus evaluated by comparing the accuracy of differential diagnosis ruled out by two observers.

Results: Kappa values for lesion features well defined border, corticated border, continuous border, effect on adjacent structures, cortical destruction, tooth displacement, root resorption and locularity were found to be 0.652, 0.151, 0.051, 0.187, 0.035, 0.348, 0.151 and 0.421 respectively which were statistically significant. Kappa values for cortical thinning and bony expansion were 0.00 which showed no correlation of these two lesion features between the modalities. The Cochran-Mantel-Haenszel test for lesion shape and internal contents were $p>0.05$ which was statistically insignificant. The diagnostic accuracy between OPG and CBCT was statistically significant with $p=0.003$ ($p<0.05$).

Conclusion: Thus, CBCT proved to be superior to PAN in terms of diagnostic accuracy of intraosseous jaw

lesions although it is advised to perform study with larger sample size and broad range of pathology.

Keywords: Pantomography, Cone Beam Computed Tomography, Diagnostic Accuracy, Intraosseous Lesions.

Introduction

Imaging of lesions within the maxilla and mandible is often fraught with difficulty owing to the similarity in the imaging appearance of a diverse array of pathologic processes. Lesions arise principally from odontogenic or non-odontogenic sources. The response of the cancellous and cortical bone to pathologic insult can be expressed either through an osteolytic or osteoblastic response thus they can be cystic or lytic, sclerotic or mixture of the two. The degree of osseous rarefaction and remodeling differ among inflammatory, benign and malignant lesions and it is this feature, along with the location of the lesion which allows for differentiation[1].

A variety of benign and malignant lesions occur within the jaws. Precise radiological evaluation of a lesion can have significant impact on diagnosis and subsequent patient treatment[2]. Conventional radiographs including Orthopantomography (OPG/ PAN) play a significant role in detecting, treating and following up on bone pathological lesion cases. Due to easy access and low radiation dose, orthopantomography radiographs has become an integral part in the diagnosis of intraosseous lesions[3].

The use of CBCT has a wide range of clinical applications in dentistry. As it produces three dimensional assessment, it can be used to detect the amount of expansion both antero-posteriorly and buccolingually in intraosseous jaw pathological lesions. Pathology may influence the surrounding normal tissue and CBCT provides information about these relationships[4].

There are few studies in the literature where radiographic examinations were performed for certain features in maxillofacial region using the two modalities namely Orthopantomography and Cone beam computed tomography alone or in comparision with other modalities. A very few were published to rule out better diagnostic imaging modality between CBCT and OPG inspite of their advantages and disadvantages[5,6].

Therefore, this study is undertaken to findout the diagnostic accuracy between OPG and CBCT where comparision will be done based on certain criterias.

Aim and Objectives

Aim : To evaluate the diagnostic accuracy of Panoramic (PAN) images compared to Cone beam computed tomography (CBCT) images in the diagnosis of intraosseous maxilla-mandibular jaw lesions.

Objectives

1. To determine whether the radiographic features of intraosseous jaw lesions appear differently on panoramic radiography and cone beam computed tomography.
2. To determine the diagnostic accuracy between PAN and CBCT images by ruling out the differences in differential diagnosis provided by the observers after analyzing each modality which were provided in order of confidence associated with each differenential diagnosis.

Materials and Methods

Type of study: This study is an Observational retrospective study.

Source of data: Panoramic (PAN) images and Cone beam computed tomography (CBCT) records with intraosseous jaw bone pathology.

Method of collection of data

Data were collected on CD drives and on PAN and CBCT films of patients with intraosseous pathology of mandible and maxilla. During the course of the study, the confidentiality of the patients were maintained.

Sample size: 30 sets of PAN images and CBCT volumes that is total of 60 images.

Inclusion criteria

1. PAN images and CBCT scans of same patient done within three months of each other.
2. PAN and CBCT images with jaw evident lesions.
3. Radiographs of biopsy-proven lesions of mandible and maxilla.

Exclusion criteria

1. Soft tissue lesions.
2. Incomplete patient records.
3. Inconclusive biopsy results.
4. PAN or CBCT images of poor diagnostic quality or which did not cover the area of interest or the contralateral side of the jaw.
5. Surgical intervention before acquisition of PAN and CBCT images.

Methodology

The study was approved by the institutional ethical committee; this is a retrospective observational study in which 30 sets of PAN and CBCT images of biopsy-proven intraosseous jaw lesions were evaluated.

All the CBCT images obtained with a NewTom 3D imaging system with medium volume and high resolution. The exposing parameters were 10.8mA, 90kV, 3.6 time seconds, 180.60mGycm² and varying field of view and were analyzed using NewTom NNT viewer software and also on films(hard copy). All the PAN images were obtained from the CS 8100 Carestream Panoramic and Cephalometric machine with exposing parameters of 73kV, tube current 10mA, 10.8 time seconds and 102 mGycm².

Radiographic examination - All scans were observed and analyzed by two observers who were blind to each other during the study. They reviewed the PAN images and CBCT volumes in a dimly lit room, using a monitor with a resolution of at least 1680 × 1050 pixels. They were allowed to navigate and manipulate the images to adjust magnification, brightness, and contrast and to create volume renders and custom-sections on the CBCT images. They also reviewed PAN and CBCT images on films using X-ray viewer with LED. No clinical informations were provided and no time restrictions were imposed on the two observers[10].

After reviewing each PAN image or CBCT volume, the observers were provided with a series of questions with respect to the lesion features during the analyzing period[10]. The set of questions were –

1. What is the lesion's shape?
2. Are its borders well defined?
3. Are its borders well corticated in terms of thickness?
4. Are its borders continuously corticated?
5. Whether the lesion is radiolucent /mixed/ radiopaque?
6. Is the lesion multilocular?
7. Does it appear to be affecting the adjacent vital structures?
8. Does it appear to expand the normal surrounding anatomic boundaries?
9. Does it appear to be causing cortical thinning?
10. Does it appear to be causing cortical destruction?
11. Does it appear to be causing tooth displacement?
12. Does it appear to be causing root resorption?

All the images were examined based on these questions criteria.

For question 1, observers were asked to describe a lesion's shape as "round/ovoid," "scalloped," or "irregular." And for question 5 (internal contents), the possible options included were "radiolucent," "mixed," or "radiopaque" for PAN and "equal to soft tissue density or lower," "mixed," or "equal to bone density or higher" for CBCT. The answer options for the remaining questions were structured as "yes" or "no." These questions were in relation to border definition (question 2); cortication of border in terms of thickness (question 3); continuity of corticated borders (question 4); multilocularity (question 6); effects on the incisive canal or inferior alveolar canal (IAC) (question 7); expansion of anatomic boundaries (question 8); cortical thinning (question 9); cortical destruction (question 10); tooth displacement (question 11); and root resorption (question 12). Observers answered "yes" if they could see any evidence of the above features, and "no" if otherwise. The observers were also allowed to answer "cannot tell" if they were unable to assess the lesion[5].

The two observers after analyzing and comparing these lesion features on each imaging modality provided two or three differential diagnoses in order of ranks (1st , 2nd and 3rd) as well as their confidence associated with each differential diagnosis based on the order of listing while using either modality as per Lim et al.[5]

Thus, the diagnostic accuracy of PAN radiography and CBCT volumes were evaluated by comparing the accuracy of differential diagnosis ruled out by the two observers.

Statistical data analysis

- Statistical data were analyzed by Statistical package for social studies software program with indicated methods.
- Data was analyzed using SPSS version 23.
- Descriptives, Frequencies, Chi sq Test were used for inter modality comparison.
- Kappa statistics were done for inter observer variability and to compare agreement for various parameters between OPG and CBCT.

Kappa values ranged from 0.01- 0.99. The Strength of agreement is interpreted as follows:

- 0.01-0.20: Slight,
- 0.21-0.40: Fair,
- 0.41-0.60: Moderate,
- 0.61-0.80: Substantial,
- 0.81-0.99: Almost perfect

The Cochran-Mantel-Haenszel test was used for "lesion shape" and "internal lesion contents". If p-value is less than 0.05 it was considered as significant.

The Cochran-Mantel-Haenszel test was also used to assess whether there was a difference in the distribution of instances when the correct diagnosis was obtained, and the distribution of weighted confidence scores when the correct diagnosis was obtained in the 2 modalities.

Observers' confidence was weighted more heavily when they provided the correct diagnosis. The weights assigned for confidence were 3 points if the observer stated the correct diagnosis on his or her first differential diagnosis; 2 points on the second; 1 point on the third; and 0 points if the correct diagnosis was not stated.

Diagnostic accuracy was calculated using Reliability test.

Pooled frequency of correct diagnosis for both OPG and CBCT was done using the Cochran-Mantel-Haenszel test.

Results

All the data was analyzed using SPSS version 23.

Descriptives, Frequencies, Chi sq Test done for inter modality comparison and Kappa statistics were done for inter observer variability. The kappa values for strength of agreement were mentioned in decimal values. The Cochran-Mantel-Haenszel test was done for "lesion shape" and "internal contents" because the answer options for these two features were not binary.

Distribution of lesions involved in the study

The summary of the lesions in the study – Total lesions were 30 out of which 10 were benign tumors with 33.34%

, 12 were cysts with 40% , 6 were inflammatory lesions with 20% and 2 belonging to other categories with 6.67%. 7 out of 12 were Radicular cysts, 3 out of 12 were Dentigerous cysts, 1 was Residual cyst and 1 was Stafne's bone cyst. 4 out of 10 benign tumors were KCOT, 2 were Ameloblastoma, 2 were CEOT and 2 were AOT. 4 out of 6 inflammatory lesions were periapical granuloma and 2 belonged to Chronic osteomyelitis. 2 miscellaneous lesions were compound odontoma. **(Table 1)**

Our study included broad range of lesions with most common being cysts followed by benign tumors and inflammatory lesions.

Mean age of study population

Total number of males in the study was 17 with minimum age of 16 years and maximum age of 56 years. Total number of females in the study was 13 with minimum age of 15 years and maximum age of 53 years. Overall minimum age was 15 years and maximum age was 56 years. The mean age for males in the study was 40.65 ± 11.694 years and for females was 35.08 ± 12.217 years. The mean age for overall population in the study was 38.23 ± 12.045 years. **(Table 2) (Graph 1)**

Overall agreement of parameters between OPG and CBCT

The kappa values for well defined border, corticated border, continuous cortication, effect on adjacent structures, tooth displacement, root resorption, cortical destruction and multilocularity were 0.652, 0.151, 0.051, 0.187, 0.348, 0.151, 0.035, 0.421 respectively. The kappa values for cortical thinning and bony expansion were 0.00. **(Table 3) (Graph 2)**

This shows that there was substantial agreement between OPG and CBCT for border definition, moderate agreement for multilocularity, fair agreement for tooth displacement and slight agreement for corticated border, continuous cortication, effect on adjacent structures, root resorption and cortical destruction.

Thus, the highest percentage of disparity between OPG and CBCT was seen with corticated border, continuous cortication, effect on adjacent structures, root resorption and cortical destruction and no correlation was found between OPG and CBCT for cortical thinning and cortical bony expansion.

Comparison of lesion features "lesion shape" and "lesion contents"

The Cochran value and Mantel-Haenszel value for lesion shape were 19.88 and 7.99 respectively. The p value was found to be p=0.119 and p=0.264. The Cochran value and Mantel-Haenszel value for lesion contents were 12.2 and 8.1 respectively. The p value for both was p=0.112 and p=0.462. **(Table 4 and 5) (Graph 3 and 4)**

There was no statistically significant difference present in lesion shape and lesion contents in OPG and CBCT when compared. Analysis with the Cochran-Mantel-Haenszel test found no association between any modality for lesion shape or lesion contents.

Comparison of diagnostic accuracy between OPG and CBCT

The comparison of diagnostic accuracy between OPG and CBCT is done by Reliability test. 70% and 43.3% accuracy was seen on first differential diagnosis (D/D1) for CBCT and OPG respectively. 13.3% and 16.7% accuracy was seen on second differential diagnosis (D/D2) for CBCT and OPG respectively. 16.7% and 26.7% accuracy was seen on third differential diagnosis (D/D3) for CBCT and OPG respectively. The p value was found to be 0.003 ($p<0.05$). **(Table 6) (Graph 5)**

There was statistically significant difference present in the confirmation of diagnoses between OPG and CBCT with CBCT having the highest accuracy in diagnosis of the lesion (D/D 1 = 70% of cases).

Average confidence of the observers' on PAN and CBCT

The average confidence of the observers' first differential diagnosis on PAN and CBCT, regardless of whether their diagnoses were correct was mentioned in **(Table 7) (Graph 6)** .

Observer 1 and 2 showed increase in confidence with CBCT compared with PAN (2.53 vs 1.9 and 2.43 vs 1.87 respectively). The confidence intervals were higher for CBCT when compared with OPG diagnosis. The inter-observer confidence levels remained same which indicate that there was no observer bias.

Frequencies of correct diagnoses provided by the observers on PAN versus CBCT

The frequencies of correct diagnoses provided by the observers on PAN versus CBCT regardless of the rank at which the correct diagnosis was provided. In 83.4% of cases, the observers provided the correct diagnosis on both PAN and CBCT. In 13.3% of cases, the observers provided the correct diagnosis on CBCT, but not on PAN. The reverse was true in 3.3% of cases. The Cochran value and Mantel-Haenszel value were 0.153 and 1.163 respectively. The p values for both the tests were p=0.690 and p=0.281. **(Table 8)**

Analysis with the Cochran-Mantel-Haenszel test showed that there was no association between the 2 modalities and the rank at which the correct differential diagnoses were made. Moreover, the p value was > 0.05 which was not statistically significant.

Table 1: Summary of lesions by category

Category	Diagnosis	Numbers (N)	Total	Percentage (%)
Cysts	• Radicular cyst • Dentigerous cyst • Residual cyst • Stafne's bone cyst	7 3 1 1	12	40
Benign Tumors	• Keratocystic odontogenic tumor (KCOT) • Ameloblastoma • Calcifying epithelial odontogenic tumor (CEOT) • Adenomatoid odontogenic tumor (AOT)	4 2 2 2	10	33.34
Inflammatory Lesions	• Periapical granuloma • Osteomyelitis	4 2	6	20
Miscellaneous	• Compound Odontoma	2	2	6.67
Total			30	100

Table 2: Mean age of study population

Gender	N	Minimum age	Maximum age	Mean age	Std. Deviation
Males	17	16	56	40.65	11.694
Females	13	15	53	35.08	12.217
Overall	30	15	56	38.23	12.045

Table 3: Comparison of agreement of various parameters between OPG and CBCT

Parameter	Yes		No		Kappa	Upper	Lower
	N	%	N	%			
Well Defined Border	20	66.7	10	33.3	0.652	0	1
Corticated Border	16	53.3	14	46.7	0.151	0.04	0.220
Continuous Cortication	14	46.7	16	53.3	0.051	0	1
Effect on adjacent structures	20	66.7	10	33.3	0.187	0.170	0.536
Bony Expansion	0	0	30	100	-	-	-
Cortical Thinning	0	0	30	100	-	-	-
Tooth Displacement	25	83.3	5	16.7	0.348	0.111	0.124
Root Resorption	21	70.0	9	30.0	0.151	0.057	0.577
Cortical Destruction	4	13.34	26	86.67	0.035	0.028	0.723
Multilocularity	27	90	3	10	0.421	0.211	0.784

Table 4: Comparison of lesion shape

	OPG		CBCT	
Parameter	N	%	N	%
Cannot Tell	6	20.0	11	36.7
Oval	13	43.3	13	43.3
Round	10	33.3	2	6.7
Scalloped	1	3.3	4	13.3
Cochran value		19.88	P value	0.119 NS
Mantel Haenszel Value		7.99	P value	0.264 NS

NS – Not Significant (p>0.05)

Table 5: Intergroup comparison of Lesion contents

	OPG		CBCT	
Type	N	%	N	%
Mixed	2	6.7	4	13.3
Radiolucent	26	86.7	24	80.0
Radiopaque	2	6.7	2	6.7
Cochran value		12.2	P value	0.112 NS
Mantel Haenszel Value		8.1	P value	0.462 NS

NS-Not Significant (p>0.05)

Table 6: Comparison of Diagnostic accuracy between OPG and CBCT

Diagnosis	OPG		CBCT	
	N	%	No	%
Unconfirmed	4	13.3	0	0
D/D 3	8	26.7	5	16.7
D/D 2	5	16.7	4	13.3
D/D 1	13	43.3	21	70.0
Total	30	100.0	30	100.0
Chi sq	19.625		P value	0.003*

*-significant (p<0.05)

Table 7: Average confidence levels of observers on their first differential diagnosis

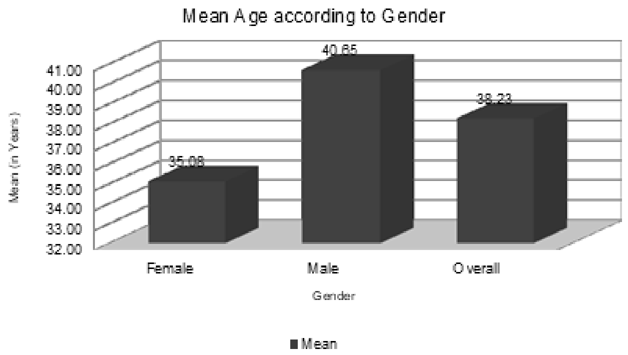
	OPG			CBCT		
Observer	95%CI	Upper	Lower	95%CI	Upper	Lower
Observer 1	1.9	1.48	2.32	2.53	2.24	2.82
Observer 2	1.87	1.45	2.28	2.43	2.13	2.74

Table 8: Pooled frequency table of correct diagnosis

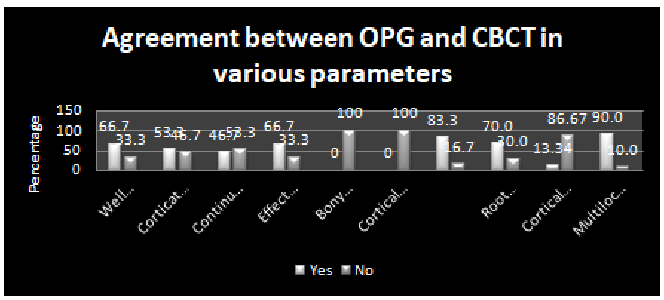
		CBCT		
		Yes	No	Total
OPG	Yes	25 (83.4)	1 (3.3)	26 (86.7)
	No	4 (13.3)	0	4 (13.3)
	Total	29 (96.7)	1 (3.3)	30 (100)
Cochran value		0.153	P value	0.690 NS
Mantel Haenszel Value		1.163	P value	0.281 NS

NS – Not significant (p>0.05)

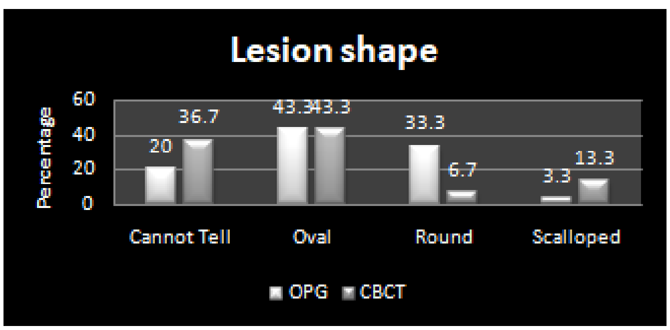
Graph 1: Mean Age of Study Population



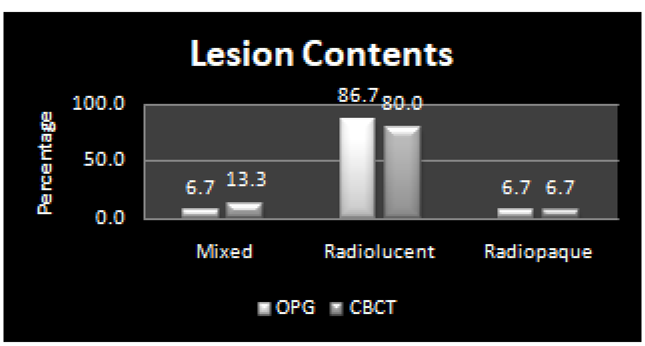
Graph 2: Comparison of agreement of various parameters between CBCT and OPG



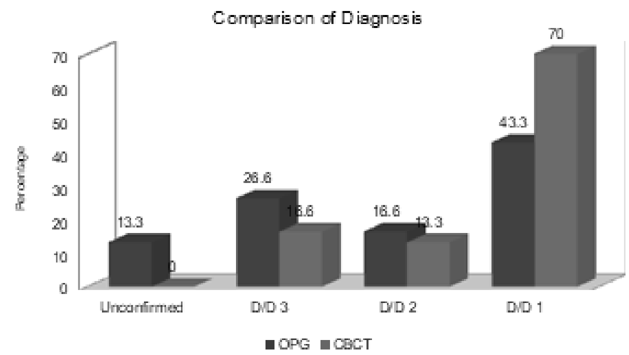
Graph 3: Comparison of four different lesion shape



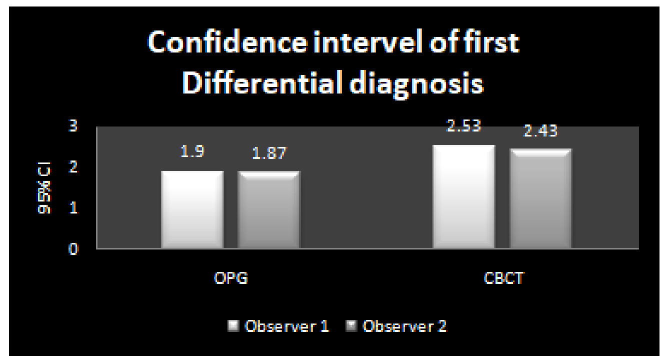
Graph 4: Percentage comparison of lesion contents



Graph 5: Comparison of Diagnostic accuracy



Graph 6: Average confidence level



Discussion

To examine a lesion radiographically, an observer always look for its certain features such as location, shape, border definition, effect on adjacent normal structures, locularity and internal contents. The radiographic diagnosis is often fraught with difficulty because of the similar radiographic findings. Therefore a thorough knowledge regarding anatomy and pathological features of imaging modalities are required for correct interpretation. OPG is the primary conventional extraoral radiograph used for screening any jaw lesion. CBCT being the advanced modality provides additional information which help in drawing differential diagnoses for a particular intraosseous jaw lesion. There are very few studies in the literature comparing diagnostic accuracy between OPG and CBCT. Therefore, this study was undertaken to rule out the diagnostic accuracy between the two modalities.

Distribution of lesions involved in the study

In our study, 12 cysts were there out of which the most frequent one was the Radicular cyst. It is the most common inflammatory cyst of the jaws arising from epithelial cell rests of Malassez usually associated with necrotic pulp. It is more commonly seen in males during 3rd and 5th decade of life according to **Koju S et al.**[7] and **Nilesh K et al.**[8] but in our study females were seen more affected with radicular cyst in 2nd and 4th decade of life. Location of the lesion is more common in anterior maxilla than mandible which was also seen in our study.

The second most common cystic lesion in our study was dentigerous cyst. It is associated with the crown of an unerupted tooth lined with reduced enamel epithelium. The developmental type according to **Benn A et al.**[9] is seen usually in the late 2nd and 3rd decades of life and the inflammatory type in the 1st and early 2nd decade. In our case, it was seen in 2nd and 3rd decades of life[10,11].

The most common benign tumor in our study was KCOT. It develops from the cell rests of dental lamina. They are usually solitary lesions which tend to grow in antero-posteior direction within the medullary cavity of the bone commonly seen in 2nd and 3rd decades of life[12,13].

Odontogenic tumors arising only from odontogenic epithelium without odontogenic ectomesenchyme include Ameloblastoma, Calcifying Epithelial Odontogenic Tumor, Adenomatoid Odontogenic Tumor. Ameloblastoma arises from any of the following remnants of dental lamina, enamel organ, odontogenic cyst lining and or oral mucosal basal cells[14]. CEOT arises from remnants of dental lamina and AOT from odontogenic epithelium around the crowns of an unerupted teeth[15,16,17]. In our study, there were equal distribution of these lesions.

The most common inflammatory lesions in our study was periapical granuloma followed by chronic osteomyelitis.

Osteomyelitis is an inflammatory condition of bone involving the medullary cavity, the Haversian systems and the adjacent cortex. Osteomyelitis of the maxilla is extremely rare[18]. Osteomyelitis of the jaws is now defined by the presence of exposed bone in the mouth, which fails to heal after appropriate intervention. The incidence of osteomyelitis has dramatically decreased since the introduction of antibiotics. Osteomyelitis is diagnosed on the basis of patient history, clinical examinations, and the surgical and radiographic findings[19].The pathogenesis of osteomyelitis of the jaws is predominately due to odontogenic microorganisms rather than the classic skin contaminant, Staphylococcus. This causative relationship relegates the classification of osteomyelitis of the bimaxillary skeleton to predominately that of contiguous foci[20]. A mixture of osteolysis and sclerosis was the most frequent imaging feature observed (68.6%), while sequestrum, extraction socket, and periosteal new bone formation were found in fewer than half of the patients[21,22].

Odontoma arises from both odontogenic epithelium and odontogenic ectomesenchyme with or without dental hard tissue formation. It is of two types- compound type which is multiple teeth like structures and complex type which is irregular masses[23]. In our study both the cases of odontoma were compound type. It is generally asymptomatic and thus, seen to be an accidental finding.

Mean age of study population

The mean age for males in the study was 40.65 ± 11.694 years and for females was 35.08 ± 12.217 years. The mean age for overall population in the study was 38.23 ± 12.045 years. Our study included a broad age range of subjects which were not mentioned in any literature.

Overall agreement of parameters between OPG and CBCT

For well defined border – the result of border definition in our study showed substantial agreement 66.7% with the study conducted by **Mao et al.**[24]on 225 lesions around 90.89%. **Lim et al.**[5] with almost same sample size reported only fair agreement 28% on border definition in their study. This could be due to lack of calibration among the observers.

For corticated border and continuous cortication – moderate agreement is seen for corticated border and continuous cortication in our study which coincides with the study of **Lim et al.**[5] , **Mao et al.**[24].This moderate agreement could be due to superimposition of features on PAN which may appear to be discontinuous on consecutive CBCT images.

Effect on adjacent structures – in our study observers found 40 out of 60 images with effect on adjacent vital structures due to pathology which shows substantial agreement with **Momin MA et al.**[25]study done on 50 patients where they concluded that the sensitivity of CBCT to detect effect on adjacent structures due to pathology is higher (89-99%) than PAN (56-73%). **Gumru B et al.**[26] on 142 patients with cement-osseous dysplasia found out that 78.2% with cortical thinning and 57.1% with root resorption on CBCT images.

Tooth displacement - In evaluating the effects of lesions on the surrounding teeth, there was substantial agreement between PAN and CBCT with respect to tooth displacement. This is consistent because tooth displacement, when it occurs, tends to be obvious radiographically. Differences are not likely to be seen unless the degree of tooth displacement is very subtle. According to **Chen et al.**[27] 3D tooth displacement can be obtained from CBCT images, and the accuracy is acceptable for clinical use and can be improved when the quality of the images improves.

Root resorption – 70% agreement is seen between PAN and CBCT in our study for tooth resorption due to intraosseous pathology. 30% disparity is due to lack of conventional radiographs like OPG to detect root resorption. **Saccomann S et al.**[28] showed in a study that OPG cannot detect root resorption with accuracy. Besides, **Estrela C et al.**[29] detected root resorption in 68.8% (83 root surfaces) of the periapical radiographs and 100% (154 root surfaces) of the CBCT scans. In the study by **Marinescu IR et al.**[30] of 240 digital panoramic radiographies, 113 cases of root resorption were identified which is less than 50% of cases.

Multilocularity – there was strong agreement around 90% between OPG and CBCT in detecting locularity of lesions. As most of the lesions included in our study were unilocular so a large sample size with broad range of jaw pathology were required to detect the efficacy of multilocurality on PAN and CBCT.

Internal contents – Our sample size was limited in that. It consisted largely of radiolucent lesions so a larger sample size with a larger proportion of radiopaque/mixed lesions is necessary for evaluating differences between PAN and CBCT.

Bony expansion, Cortical thinning (CT) and Cortical destruction (CD) – when the expansion of the lesion reaches cortical plates, CT and CD manifest. Therefore, these 3 radiographic features are in accordance with each other. CD occurs when the integrity is disrupted and CT if its still intact. These changes may not be apparent on PAN because changes may be masked by an intact buccal or lingual cortical plate. Similarity is seen with the study of **Mostafa RA et al.**[31] Another study done by **Shweel M et al.**[32] showed CBCT superior than MDCT in detecting thinning and perforation of buccal cortical plate and displacement of teeth.

Comparison of diagnostic accuracy between OPG and CBCT

In our study, the diagnostic accuracy of CBCT in relation to first differential diagnosis is found higher in 70% of cases. This is in agreement with previous studies of **Mao et al.**[24]**, Jelovac DB et al.**[33] (study done on 30 patients of tumor of maxillofacial region), *Guo J et al.*[53](study done on 36 periapical lesions), **Hendrikx AW et al.**[34] (retrospective study on 23 patients diagnosed with biopsy-proven oral squammous cell carcinoma (OSCC) of mandible) and **Islam MA et al.**[35] found that diagnostic accuracy of CBCT was better than Panoramic Radiography and MRI in detecting mandibular invasion.

Another study by **Kammerer PW et al.**[36] showed that evaluation of CBCT images alters the execution of treatment planning. This could be due to 3D and multiplanar options of CBCT which lacks in PAN. The study by **Hedge V et al.**[37] also showed better accuracy of CBCT than PAN and CT in detecting incipient bony changes. **Schulze D et al.**[38] also showed that CBCT is better imaging modality than OPG interms of diagnostic accuracy. Another study done by **Simon JHS et al.**[39] showed efficacy of CBCT and comparable to biopsy in determining diagnosis.

The accuracy of the first differential diagnosis on CBCT was higher than that on PAN of our study contradicted with the study of **Lim et al.**[5] and **JavadianLangaroodi A et al.**[6] (study on diagnostic accuracy of OPG and CBCT imaging of 61 patients with intraosseous lesions) and **Mostafa RA et al.**[24]

Average confidence of the observers' on PAN and CBCT

Both the observers showed increase in confidence with CBCT compared with PAN. This is in accordance with **Mao et al.**[24]whereboth observers had higher confidence scores on CBCT compared to PAN. According to **Lim et al.**[5] Observers 1 and 2 showed a slight increase in confidence with CBCT compared with PAN and Observer 3 had the same confidence with both PAN and CBCT.

Frequencies of correct diagnoses provided by the observers on PAN versus CBCT

In our study, the observers provided the correct diagnosis on both PAN and CBCT in 83.4% of cases whereas in **Lim et al.**[5]study, the observers provided the correct diagnosis on both PAN and CBCT in 53.76% cases.

Thus, Results of many studies from the literature show that significant differences are noted in the radiographical features of intraosseous lesions done on CBCT compared to PAN/OPG and Diagnostic accuracy of CBCT is superior compared to PAN/OPG.

Conclusion

Pathologic conditions of the jaw are common yet they are not frequently imaged or encountered by radiologists. It is therefore, important for radiologists to familiarize themselves with jaw pathology to ensure appropriate patient care.

Cone beam computed tomography being an advanced imaging modality demonstrated a greater number of imaging characteristics of intraosseous jaw lesions compared to Panoramic radiography. Its three dimensional feature enable the observer to view the lesion in all three orthogonal planes. Some lesion features are mentioned well in cone beam computed tomography such as bony expansion, cortical destruction, effect on adjacent structures.

Orthopantomography (OPG/PAN) being two dimensional showed substantial agreement with CBCT in some criterias namely border definition, cortication of border, locularity. The present study found diagnostic accuracy improved with CBCT compared to PAN for both the observers.

Moreover, there was 85 percent coincidence in interobserver variability. Thus, CBCT should be considered for radiological examination of intraosseous lesions to reach to a final diagnosis and execute treatment planning for the same.

Further studies are suggested with an extensive sample size and lesions to substantiate the results as well as to better understand the importance of use of CBCT in diagnosing disease lesions and determining proper diagnosis and subsequent treatment planning.

References

1. Mosier KM. Lesions of the Jaw. Semin Ultrasound CT MR. 2015 Oct;36(5):444-50.
2. Dunfee BL, Sakai O, Pistey R, Gohel A. Radiologic and pathologic characteristics of benign and malignant lesions of the mandible. Radiographics. 2006 Nov-Dec;26(6):1751-68.
3. Bayrakdar IS, Yilmaz AB, Caglayan F, Ertas U, Gundogdu C, Gumussoy I. Cone beam computed tomography and ultrasonography imaging of benign intraosseous jaw lesion: a prospective radiopathological study. Clin Oral Investig. 2018 Apr;22(3):1531-1539.
4. JavadianLangaroodi A, Lari SS, Shokri A, HoseiniZarch SH, Jamshidi S, Akbari P. Intraosseous benign lesions of the jaws: a radiographic study. Iran J Radiol. 2014;11(1):e7683.
5. Lim LZ, Padilla RJ, Reside GJ, Tyndall DA. Comparing panoramic radiographs and cone beam computed tomography: Impact on radiographic features and differential diagnoses. Oral Surg Oral Med Oral Pathol Oral Radiol. 2018;126:63-71.
6. Mishra S, Degwekar S, Banode P, Bhowate R, Motwanin M, Mishra P. Comparative study of cone-beam computed tomography and multislice computed tomography in the radiographic evaluation of cysts and tumors of the jaw. Journal of indian academy of oral medicine and radiology.2014 Nov; 26:253-259.
7. Koju S, Chaurasia NK, Marla V, Niroula D, Poudel P. Radicular cyst of the anterior maxilla: An insight into the most common inflammatory cyst of the jaws. J Dent Res Rev 2019;6:26-9.
8. Nilesh K, Dadhich AS, Chandrappa PR. Unusually large radicular cysts of maxilla: Steps in diagnosis & review of management. J Biol Innov. 2015;4:1-11.
9. Benn A, Altini M. Dentigerous cysts of inflammatory origin. A clinicopathologic study. Oral Surg Oral Med Oral Pathol Oral RadiolEndod. 1996 Feb;81(2):203–209.
10. Bhardwaj B, Sharma S, Chitlangia P, Agarwal P, Bhamboo A, Rastogi K. Mandibular Dentigerous Cyst in a 10-Year-Old Child. Int J Clin Pediatr Dent. 2016;9(3):281-284.
11. Cury SE, Cury MD, Pontes FS, Pontes HA, Rodini C, Pinto-Ddos S Jr. Bilateral dentigerous cyst in a nonsyndromic patient: case report and literature review. J Dent Child. 2009 Jan-Apr;76(1):92–96.
12. Blanas N., Freund B., Schwartz M., Furst I.M. Systematic review of the treatment and prognosis of the odontogenic keratocyst. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod. 2000;90:553.

13. Abdullah WA. Surgical treatment of keratocystic odontogenic tumour: A review article. Saudi Dent J. 2011;23(2):61-65.
14. Effiom OA, Ogundana OM, Akinshipo AO, Akintoye SO. Ameloblastoma: current etiopathological concepts and management. Oral Dis. 2018 Apr;24(3):307-316.
15. Poulson TC, Greer RO. Adenomatoid odontogenic tumor: clinicopathologic and ultrastructural concepts. J Oral Maxillofac Surg. 1983 Dec;41(12):818-24.
16. Mendis BR, MacDonald DG. Adenomatoid odontogenic tumour. A survey of 21 cases from Sri Lanka. Int J Oral Maxillofac Surg. 1990 Jun;19(3):141-3.
17. Kamboj M, Yadav AB, Narwal A, J N. Unusual Cystic Variant of Calcifying Epithelial Odontogenic Tumor. J Dent. 2020 Jun;21(2):147-152.
18. Emmanuel LA, Cornah J. Osteomyelitis of the jaws: A review of 141 cases. British Journal of Oral and Maxillofacial Surgery. 1985;23(1):24–35.
19. Nezafati S, Ghavimi MA, Yavari AS. Localized osteomyelitis of the mandible secondary to dental treatment: report of a case. J Dent Res Dent Clin Dent Prospects. 2009;3(2):67-69.
20. Hudson JW. Osteomyelitis of the jaws: a 50-year perspective. J Oral Maxillofac Surg. 1993 Dec;51(12):1294-301.
21. Shin JW, Kim JE, Huh KH, et al. Clinical and panoramic radiographic features of osteomyelitis of the jaw: A comparison between antiresorptive medication-related and medication-unrelated conditions. Imaging Sci Dent. 2019;49(4):287-294.
22. Nezafati S, Ghavimi MA, Yavari AS. Localized osteomyelitis of the mandible secondary to dental treatment: report of a case. J Dent Res Dent Clin Dent Prospects. 2009;3(2):67-69.
23. Slootweg PJ. An analysis of the interrelationship of the mixed odontogenic tumors--ameloblastic fibroma, ameloblastic fibro-odontoma, and the odontomas. Oral Surg Oral Med Oral Pathol. 1981 Mar;51(3):266-76.
24. Hegde V, Naikmasur VG , Burde KN , Jayade GR. Validity of Orthopantomograph, Cone Beam Computed Tomography and CT for assessment of simulated lesions over mandibular condyle. Journal of Oral Medicine, Oral Surgery, Oral Pathology and Oral Radiology. 2017; 3(3):142-148.
25. Guo J, Simon JH, Sedghizadeh P, Soliman ON, Chapman T, Enciso R. Evaluation of the reliability and accuracy of using cone-beam computed tomography for diagnosing periapical cysts from granulomas. J Endod. 2013 Dec;39(12):1485-90.
26. Momin MA, Okochi K, Watanabe H, et al. Diagnostic accuracy of cone-beam CT in the assessment of mandibular invasion of lower gingival carcinoma: comparison with conventional panoramic radiography. Eur J Radiol. 2009;72:75-81.
27. Chen J, Li S, Fang S. Quantification of tooth displacement from cone-beam computed tomography images. Am J Orthod Dentofacial Orthop. 2009 Sep;136(3):393-400.
28. Hansen SL, Huumonen S, Gröndahl K, Gröndahl HG. Limited cone-beam CT and intraoral radiography for the diagnosis of periapical pathology. 2007;103(1):1–119.
29. Noujeim M, Prihoda T, Langlais R, Nummikoski P. Evaluation of high-resolution cone beam computed tomography in the detection of simulated interradicular bone lesions. DentomaxillofacRadiol. 2009 Mar;38(3):156-62.

30. Marinescu IRet al. Root Resorption Diagnostic: Role of Digital Panoramic Radiography. Curr Health Sci J. 2019;45(2):156-166.
31. Kämmerer PW, Thiem D, Eisenbei C. Surgical evaluation of panoramic radiography and cone beam computed tomography for therapy planning of bisphosphonate-related osteonecrosis of the jaws. Oral Surg Oral Med Oral Pathol Oral Radiol. 2016;121:419-424.
32. Park YC, Lee W, Lee BD. Radiographic evaluation of dentigerous cyst with cone beam CT. Korean J Oral MaxillofacRadiol. 2010;40:115-21.
33. Jelovac DB, Konstantinović VS, Mudrak J, Šabani M. Diagnostic accuracy of cone-beam CT in the assessment of bone invasion by malignancies in maxillofacial region and treatment outcome-prospective study. International Journal of Oral and Maxillofacial Surgery. 2015;44(1):85.
34. Shweel M, Amer IM, Fathy A. A comparative study of cone-beam CT and multidetector CT in the preoperative assessment of odontogenic cysts and tumors. The Egyptian Journal of Radiology and Nuclear Medicine. 2013;44(1):23-32.
35. Zainab A. CBCT Analysis of Impacted Maxillary Canines. Journal of Baghdad College of Dentistry. 2013;25:114-118.
36. Estrela C, Bueno MR, De Alencar AH, Mattar R, Valladares Neto J, Azevedo BC, De Araújo Estrela CR. Method to evaluate inflammatory root resorption by using cone beam computed tomography. J Endod. 2009 Nov;35(11):1491-7.
37. Hosseini ZSH, Langaroodi JA, Noghabi TA. Accuracy of Conventional Radiography in Differentiating Between Benign Lesions and Malignant Ones in the Maxillofacial Region. J Mashhad Dent Sch. 2009;33(2):121–8.
38. Schulze D, Blessmann M, Pohlenz P, Wagner KW, Heiland M. Diagnostic criteria for the detection of mandibular osteomyelitis using cone-beam computed tomography. Dentomaxillofacial Radiology. 2006;35(4):232–235.
39. Simon JHS, Enciso R, Malfaz JM, Roges R, Perry MB, Patel A. Differential Diagnosis of Large Periapical Lesions Using Cone-Beam Computed Tomography Measurements and Biopsy.2006; 32(9):1–837.

Legend Figures

Fig 1: OPG showing poor border definition of Radicular cyst in second quadrant.

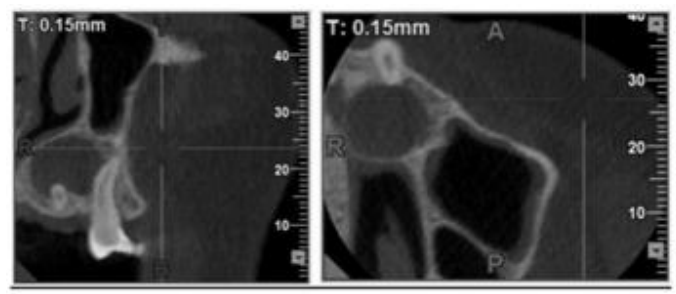


Fig 2: Well defined border definition of Radicular cyst seen in coronal sections of CBCT.

Fig 3: Cortical thinning of Residual cyst not visible in OPG.

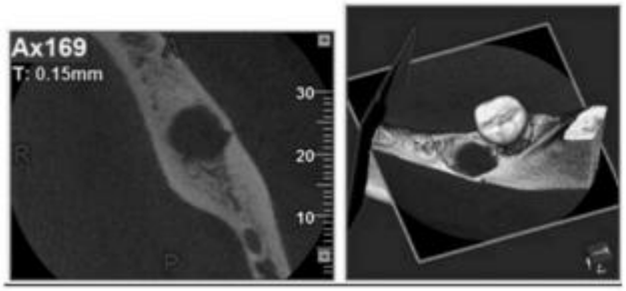


Fig 4: Cortical thinning of Residual cyst seen on CBCT sections.

Fig 5: OPG showing Periapical granuloma in canine region of first quadrant.

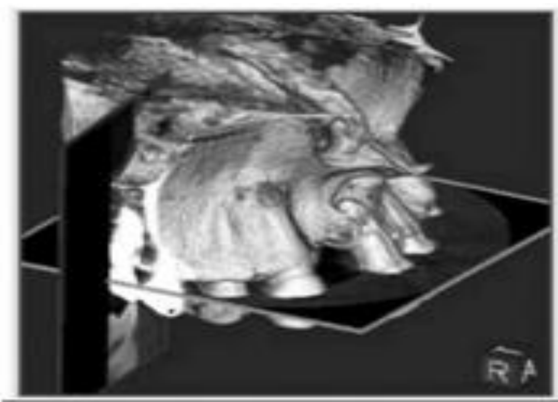


Fig 6: CBCT section of Periapical granuloma showing cortical destruction in canine region.

Fig 7 : Ameloblastoma of right mandible showing multilocularity, root resorption and cortical destuction.

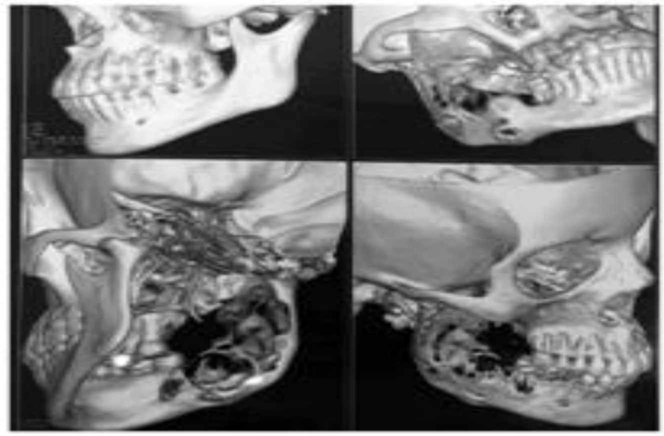


Fig 8 : Ameloblastoma of right mandible showing multilocularity, bony expansion, cortical thinning and destruction in CBCT views.

Fig 9: OKC of anterior mandible showing scalloped border in OPG.

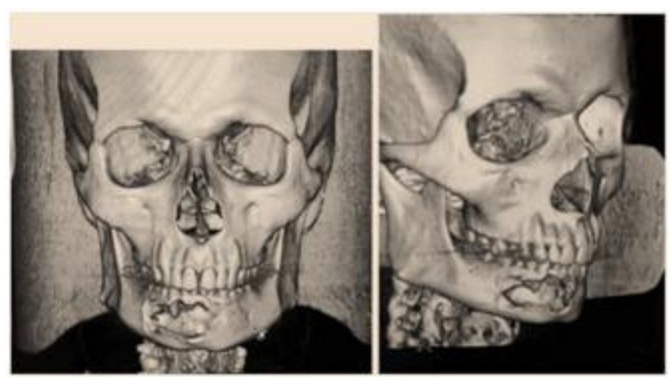


Fig 10: OKC of anterior mandible showing scalloped border, tooth displacement, cortical destruction.