"CBCT- a game changer in assessing osseous changes of TMJ: A comparative study to OPG"

Dr. Mounika Prashanthi N[1], Dr. Jaishankar H P[2], Dr. Karthikeya Patil[3] Prasannasrinivas Deshpande[4]

[1] Postgraduate Student , Department of Oral Medicine and Radiology, JSS Dental College and Hospital, JSS Academy of Higher Education and Research (JSSAHER), Mysuru.

[2] Reader, Department of Oral Medicine and Radiology, JSS Dental College and Hospital JSS Academy of Higher Education and Research (JSSAHER), Mysuru.

[3] Professor and Head, Department of Oral Medicine and Radiology, JSS Dental College and Hospital, JSS Academy of Higher Education and Research (JSSAHER), Mysuru.

[4] Senior Lecturer, Department of Oral Medicine and Radiology, JSS Dental College and Hospital, JSS Academy of Higher Education and Research (JSSAHER), Mysuru.

*Corresponding Author

Dr. Jaishankar H P, Reader, Department of Oral Medicine and Radiology, JSS Dental College and Hospital, JSS Academy of Higher Education and Research (JSSAHER), Mysuru

Email: drjaishankarhp_dch@jssuni.edu.in

Abstract

Introduction:

Temporomandibular joint is an important component of the masticatory system and an extremely complex synovial joint that permits translation, gliding, forward and backward movement for mastication and speech. Radiographic examination is an essential diagnostic tool for the diagnosis of temporomandibular joint disorders. To establish the accurate diagnosis, radiographs precise the clinical diagnosis.

Aim& Objectives:

- To determine the osseous changes as seen on OPG and CBCT in different age groups.
- To ascertain better imaging modality for the investigation of the osseous changes in the TMJ.
- To propose a most suitable imaging modality for investigation of osseous changes in the TMJ.

Materials and method:

Patient within the age limit of 20 – 60 years who visited JSS Dental college and hospital with the complaint of pain in relation to TMJ were selected for the study. 10 selected subjects were clinically examined along with case history recording. The subjects were subjected to OPG and CBCT examination with their consent on Planmeca Promax 3 D machine. The images were evaluated by three examiners independently and statistical evaluation was done.

Results:

60% of the sample were in the age group of 20-30, with more female samples among the total samples. Flattening and Erosion were seen on OPG while all the morphological changes were appreciated on CBCT.

Conclusion :
From the obtained results we would like to propose that CBCT as a better radiographic modality compared to OPG for evaluation of condylar changes.
Keywords: CBCT, Erosion, OPG, Osseous changes, Temporomandibular joint

Introduction

Temporomandibular joint (TMJ), an extremely complex synovial joint helps in mastication, speech, and swallowing. [1] It receives its name from two bones namely Temporal bone and Mandible. [2]

TMJ projections like Transcranial, Transpharyngeal, conventional tomography, Reverse Towne's technique projections and Orthopantomogram provides gross details about the osseous changes of the condyle, articular eminence and articular fossa. CBCT produces images in three dimensions namely sagittal, axial and coronal which enables the radiologist to interpret and diagnose more precisely. [3]

The various osseous changes observed radiographically involving the TMJ are Flattening, Erosion, Osteophyte, Sclerosis and Ely's cyst.

Materials and methods

Following the approval from the Institutional Ethical Committee (28/2018), study was conducted for a duration of 5 months. The study subjects constituted dental out patients visiting the Department of Oral Medicine and Radiology.

Aim & Objectives

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Sample selection criteria

The Clinical Inclusion criteria of the study included subjects with the complaint of pain or clicking sounds in the TMJ region between 20 to 60 years of age and who were interested to participate in the study, patients with minimum number of teeth in both the arches to have a proper occlusion. Radiological inclusion and exclusion criteria included OPG and CBCT images which show proper visibility of both the TMJ with required anatomical landmarks, OPG and CBCT images with poor visibility of required landmarks including TMJ and condyle were excluded along with those showing central pathology/ cysts/ tumors involving condyle, articular eminence. The following clinical Exclusion criteria like pregnant women, patients with motor disability, patients with previous history of trauma or history of surgery to the condyle or base of the skull, developmental anomalies involving middle/lower third of face middle ear infection, cervical spondylitis. The subjects in the study who may later fall in the exclusion criteria or not willing to participate in the study were withdrawn.

Procedure

Patient within the age range of 20 – 60 years with the complaint of pain in relation to TMJ were considered for the study. A detailed case history according to WHO criteria for Temporomandibular joint diseases was recorded. Patients with the signs and symptoms were subjected for OPG and CBCT imaging. For both the projections Planmeca Promax 3 D Mid

(manufactured by Helsinki Finland) machine was used in 2D and 3D options with Automatic Exposure Control. Patients head position was stabilized using cephalostat with Frankfort horizontal plane of the patient adjusted parallel to the floor.

The 10 OPG and CBCT images provided 20 TMJ's out of which 14 were of females and 6 were of males. Images fulfilling the diagnostic quality were considered in the study and those without were rejected. The OPG image were viewed on 2D Planmeca Romexis software and TMJ volume obtained were analyzed over 3 D Planmeca Romexis software. Patients were exposed to radiations with two modalities on the alternate days to follow ALARA principle. Exposure parameters for the procedure the mentioned in table 1.

Two evaluators who were specialised in Oral Medicine and Radiology were chosen for image interpretation after extensive training session and standardisation for the interpretation of the morphological changes seen on condyle, with the help of few images from the data base (Figure1). Radiographic changes of the condyle were recorded according to the definitions given by "Muir and Goss 1990 , Akerman et al. , and Flygare".

Results

Table 2 and 3 depicts the of age and gender, the outcomes obtained on the statistical evaluation by two evaluators for OPG and CBCT are mentioned in table 4 and 5. Significant results were obtained on comparison of the interpretation of OPG with that of CBCT of the same evaluator, where as the results were non-significant with $p = 0.407$ and 1.000 respectively on comparison of OPG and CBCT of the other evaluator on application of Chi-square test.

Discussion

Temporomandibular joint is one important joint in the head and neck region. Temporomandibular disorders (TMD) are heterogeneous set of complex disorders of multifactorial aetiologies. These disorders include the masticatory musculature, the osseous components and the soft tissue components of the TMJ including the articular disc and its ligamentous attachments. Imaging is a major diagnostic adjuvant to the clinical diagnosis. Better diagnosis and treatment outcomes depend on clear and precise image of the region of interest.

Restricted mouth opening in the patients, Superimposition of adjacent structures and mandibular movements during the examination, different angulations of the condyle, presence of artefacts make the TMJ imaging difficult. Distortion of the TMJ images occurs on Orthopantomograms, due to the direction of the beam which is neither parallel nor perpendicular to the long axis of the condyle. [4] In conventional radiography the beam must pass the joint obliquely in order to avoid superimposition of anatomical structures for appreciation of hard tissues of TMJ.

Crusoé-Rebello et al., suggested that one joint have an influence of the other and cannot be considered separately, this functional unification of the joint justifies increased prevalence of bilateral osseous changes as reported by Katzberg et al. [5]

Sinha et al, upon comparison of four imaging modalities for detecting TMJ changes reported that no single imaging modality studied could accurately show all changes in the hard and soft tissues of the joint. The soft tissue defects of the joint were most accurately detected on MRI along with USG and CT provided the most accurate information about hard tissues changes. The other modality; Plain Transpharyngeal radiograph provided reasonably accurate

information regarding hard tissue changes. Although their aim to compare the images of different modalities with that of Clinical Diagnostic Criteria was not possible. [6]

An attempt was made to compare the OPG which is widely accepted and often used as a screening radiograph with CBCT for the changes of mandibular condyle to propose a most suitable modality for TMJ examination. The CBCT images acquired in three different planes namely axial plane, sagittal plane and coronal plane, can be read and interpreted separately. In order to avoid bias during the comparison of CBCT and OPG images, the two images should be in the same plane. As the OPG images will be obtained in sagittal plane, the CBCT images included in the study were also of sagittal section. The medial, mid and lateral pole slices of the CBCT image with thickness 400 μm were considered ideal to sort our purpose for the study completion of the study.

Kurita H et la[7] in their study of 89 patients to recognised the relationship between pain and morphological change of the TMJ condyle using lateral tomography projection excluded 12 joints (6 samples) because of difficulty in mapping out the outlines of the condyle during the evaluation of radiographs. The results revealed a possible relationship between pain and morphological changes like Flattening, Resorption, Sclerosis, Osteophyte in Osteoarthritis.

Anna- Karin- Abrahamsson et al[8] conducted a study to perceive the fate of Erosion in the TMJ using CT and CBCT modalities over a sample size of 22 and found that there was a high potential for repair of Erosion in adolescents. In our sample size of 20, 12 (60%) were in the age group of 20-30, 6 (30%) were in the age group of 41- 50 and 2 (10%) were in the age group of 51-60 (Table 1). Younger age group found to have more prevalence of TMD, which was similar to the study by "Anuna Leela Mathew et al". [9]

The results obtained from the present study exhibited that the most common osseous change observed was Flattening followed by Erosion, Osteophytes, and sclerosis in a sample of 70% females and 30% males. This result was in accordance with the study reported by Pontual et al. [10] in which 22% were male and 78% were female. A study by LeResche[11] espied that pain in respect to TMJ will be twice as common in females as in males. This can be justified by the contemplating prolactin and estrogen hormones as an etiology for increased articular bone and cartilage degeneration, ramifying the immunological responses occurring in females.

Anuna Laila Mathew et al [9]reported that the study conducted by them using OPG to assess the condylar changes with age showed Flattening as the most common morphological change in a sample of 75 followed by Osteophyte. As flattening is an obvious change which can be easily appreciated on 2D imaging like OPG. The results of our study are consistent with this study as well as with the studies by Alexiou et al. and Martinez Blanco et al.[12]The results acquired owing to the comparison has shown that 20% Erosion was identified in CBCT whereas OPG detected only 10%. Hence, CBCT proved to be better than OPG in detecting early osseous changes such as Erosion. Flattening and Erosion were readily appreciated on OPG samples while Flattening, Erosion, Sclerosis, Osteophyte and Ely's cyst, were observed on CBCT. This can be explained by the fact that CBCT; a 3- D imaging modality provides images in three sections with varying thickness of slices with superior imaging technique, therefore appreciating even minor osseous changes. These results are in accordance with the study of Lee et al who have detected more number of Erosions of Mandibular condyle on comparing OPG with CBCT.

Osteophyte is seen in the advanced cases with degenerative changes when the bone undergoes repair. The occurrence of Osteophyte as a result of the "occlusal forces", constitute areas of "neoformed cartilage" which stabilize and widen the surface of the condyle as an attempt to improve the load. In the 20 samples 5% of osteophytes were detected in the CBCT while they were not seen on OPG which was in accordance with the study results of "Lee et al". [4] who had done the study on 212 joints and of which 2.1% of osteophytes were seen on CBCT and 0.9% were seen on OPG, demonstrating CBCT being superior to OPG even in detecting the osteophytic changes. In this study, predominance of patients belonged to younger age group and the TMJ problem was not chronic enough to appreciate advanced bony changes.

"Sclerosis" is an area with increased density of cortical bone which extends into the bone marrow. 5% of cases on CBCT showed sclerosis while it was not detected on the OPG. The other morphological change like subcortical cysts were not detected on OPG while 5% of the samples showed Ely's cyst on CBCT. Smaller sample size can be considered as a reason for no significant difference between the samples of Sclerosis and Ely's cyst in this study.

The conspicuous osseous changes like bifid condyle, pencil shaped/ pointed condyles were not included in the study as the sole moto was to detect minuscule morphological changes on OPG and CBCT and to compare how close are the interpretation of OPG were to those of CBCT. There was inter- examiner variation between the evaluators upon the interpretation of OPG while the evaluators were in agreement with respect to the interpretation of CBCT. With the above-mentioned statistical data and its technique for obtaining the images in 3-Dimensions we would like to suggests CBCT as a better diagnostic imaging modality compared to OPG for the diagnosis of TMJ osseous defects.

Limitations of the Study

More further studies with larger sample size of chronic TMD cases might give better insight into study. The non-availability of proper diagnostic standardization for the evaluation of bony condylar changes in the available literature leads to confusion and variability among the examiners.

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Tables

Area exposed	**Dose Area Product**	**kVp**	**mA**	**FOV**	**Sec**	**Voxel**
CBCT- Full face	3632mGy*cm^2	90	8mA	20x17cms	9s	8x8x8
CBCT- Bilateral TMJ	3229 mGy*cm^2	90	8mA	4x5cms	8s	5x5x5
OPG	120mGy*cm^2	70	10mA	--	15s	
TMJ on 2 D machine	80mGy*cm^2	70	6.3MA	--	16.8s	

Table 1: Exposure parameters applied for the study

		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	20-30	12	60.0	60.0	60.0
	41-50	6	30.0	30.0	90.0
	51-60	2	10.0	10.0	100.0
	Total	20	100.0	100.0	

Table 2- Distribution of Age

		Frequency	Percent
Valid	Male	6	30.0
	Female	14	70.0
	Total	20	100.0

Table 3- Distribution of Gender

			Mode		Total
			CBCT	OPG	
E1	Seen	Count	13	2	15
		% within mode	65.0%	10.0%	37.5%
	Not seen	Count	7	18	25
		% within mode	35.0%	90.0%	62.5%
Total		Count	20	20	40
		% within mode	100.0%	100.0%	100.0%

Table 4: Values obtained by Evaluator 1 on comparison of OPG and CBCT

			Mode		Total
			CBCT	OPG	
Changes	Seen	Count	13	6	19
		% within mode	65.0%	30.0%	47.5%
	Not seen	Count	7	14	21
		% within mode	35.0%	70.0%	52.5%
Total		Count	20	20	40
		% within mode	100.0%	100.0%	100.0%

Table 5: Values obtained by Evaluator 2 on comparison of OPG and CBCT