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Research Article

CONE BEAM COMPUTED TOMOGRAPGY-A HORIZON IN TMJ DIAGNOSTICS

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A B S T R A C T

The diagnosis and treatment planning of temporomandibular joint disorders is quite challenging. Radiological examination forms an essential component for the diagnosis of temporomandibular joint disorders. Temporomandibular joint is a complex entity with hard and soft tissue components. Accurate radiographic evaluation of Temporomandibular joint has been difficult due to superimposition of other structures in conventional radiographs. Cone beam computed tomography plays an important role in precise imaging of temporomandibular joint anatomy without superimposition and distortion. It provides an accurate method for evaluating bony changes of the temporomandibular joint Cone beam computed tomography is a developing technique that is increasingly used in dentomaxillofacial imaging due to its relatively low dose high spatial resolution. The present review will give an update on cone beam computed tomography finding of temporomandibular joint disorders reported to our institution.

INTRODUCTION

Tempomandibular joint is a rather difficult area to investigate radiographically. It is a new technique producing reconstructed images of high diagnostic quality using lower radiation doses. There are different complex etiologic factors which have been implicated in the development of temporomandibular joint disorders. Conventional radiographs of the temporomandibular joint like the transpharyngeal, transcranial, orthopantomograph does not show detailed information due to the superimposition of bony structures. This permits the use of advanced three dimensional modality like the Cone Beam Computed Tomography(CBCT)[1-3] .CBCT has been introduced as scanner in 1982 at Mayo clinic and it began to be marketed during 1990s[4].The CBCT images are very useful in visualization of the temporomandibular joint among all other imaging modality. A number of studies regarding the diagnostic accuracy of this Three Dimensional imaging modality are available. The first accuracy study was published in 2005, demonstrating that CBCT provided accurate and reliable linear measurements of temporomandibular joint dimensions of dry human skulls[5]. The accuracy of cone beam computed tomography in the assessment of temporomandibular joint dimensions was confirmed in a more recent study, concluding that the measurements were very similar to the actual joint spaces. CBCT in general has an acceptable accuracy for diagnosing osseous temporomandibular joint abnormalities with high sensitivity.

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Cone beam computed tomography has largely adopted as a dental office based imaging technique.[6-7] This article mainly focuses on the Cone Beam Computed Tomography findings of temporomandibular joint disorders.

Clinical Cases and CBCT findings

A total of 250 consecutive scans were performed in patients with temporomandibular joint disorders and maxillofacial trauma at Government Dental College and Hospital, Aurangabad during the period of January 2014-September2015. All the scans were acquired using Carestream 9300 CS 3D machine. The CBCT images were obtained with a 17x13.5 cm field of view, 250x250x250 micrometers voxel size, 70 kvp, 10 ma and x-ray pulse time of 30ms.The CBCT scans were reviewed retrospectively. The CBCT revealed the following temporomandibular joint disorders which were classified as developmental, degenerative, traumatic, and benign tumors of the temporomandibular joint.

We have enlisted various conditions causing alteration in shapes and size of mandibular condyle as follows: [4]

1. ***Developmental defects***
   - Condylar hyperplasia
   - Condylar hypoplasia
   - Agenesis
   - Bifid condyle
2. ***Syndromes***
   - Hemifacial Microsomia
   - Treacher Collins Syndrome
   - Hallermann-Steiff Syndrome
   - Pierre Robin Syndrome

- Oculo mandibulo dyscephaly
- Progeria

3. ***Degenerative joint disease***
4. ***Inflammatory / infectious diseases***
   - Rheumatoid Arthitis
   - Psoriatic Arthitis
   - Septic Arthitis
5. ***Cysts of TMJ***
   - Aneurysmal Bone Cyst
   - Simple bone cyst
   - Ganglion cysts and synovial cysts
6. ***Tumours of the TMJ***
   - Osteoma
   - Osteochondroma
   - Chondroblastoma
   - Osteosarcoma
   - Ewing's sarcoma
7. ***Metabolic Disease***
   - Gout
8. ***Endocrine Disturbances***
   - Gigantism and Acromegaly
   - Hypothyroidism and Hypopituitarism
9. ***Trauma***
10. ***Radiation***

These disorders are discussed as below.

Developmental disorders

Condylar Hypoplasia

CBCT findings of condylar hyperplasia revealed proportionately smaller mandibular fossa and small size of the mandibular condyle. The ramus and mandibular body was smaller on the affected side and there was deepening of antegonial notch. Mandibular asymmetry was observed on the left side. (Figure1a & 1b)

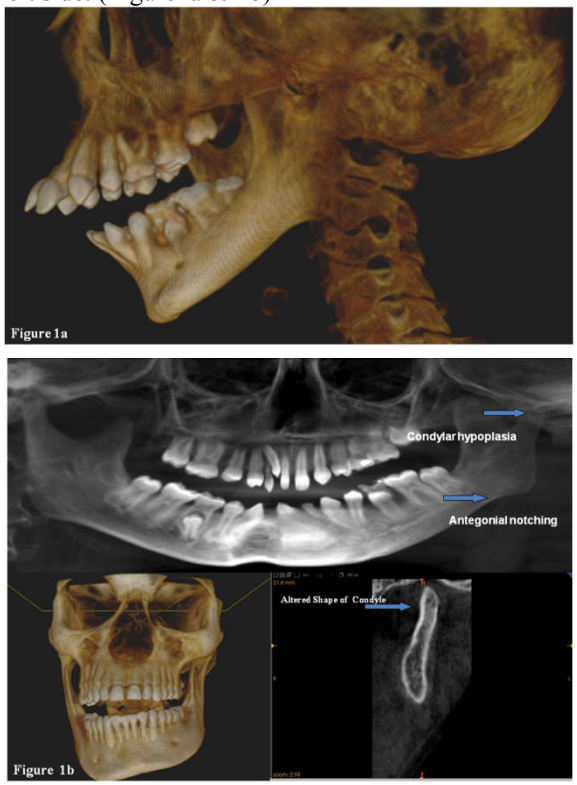

Figure 1a & 1b: Condylar Hypoplasia: Condyle - smaller Size,Mandibular fossa proportionately smaller mandibular asymmetry on Left side,Ramus & mandibular body smaller on affected side, Deepening of Antegonial notch.

Condylar Hyperplasia

The CBCT findings showed deformity and asymmetry of the mandible. The ramus and mandibular body was enlarged on the affected side. The mental foramen was placed at a lower level and there was depression of the inferior border of the midline. The condyle was enlarged on the affected side with elongation of the condylar head and neck with a forward bend forming an inverted L. The glenoid fossa was enlarged with obtuse mandibular angle. (Figure 2a & 2b)

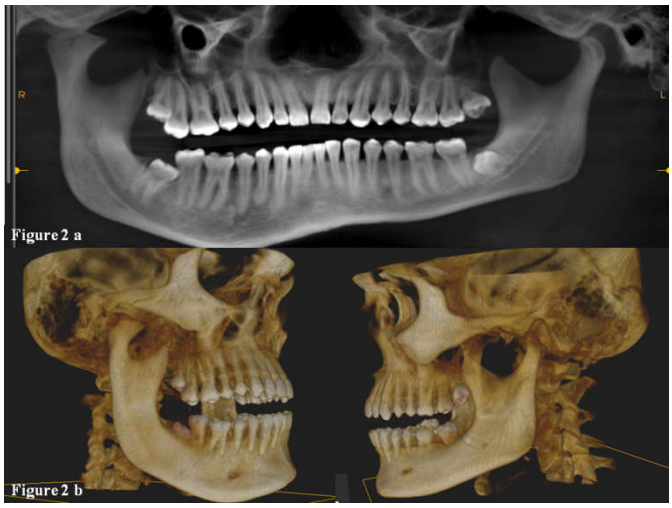

Figure 2a: Condylar Hyperplasia: Deformity & asymmetry of Mandible the Ramus and Mandibular body is enlarged on affected side Depression of the inferior border at the midline where the enlarged side joins the contra lateral normal mandible mental foramen is at lower level.

Figure 2b: Condyle enlarged on affected side Elongation of the condylar head & neck with a forward bend forming an inverted 'L' Condylar neck is elongated, thick and laterally bend Glenoid fossa is enlarged Angle of Mandible is obtuse.

Bifid Condyle

The CBCT findings revealed a depression (notch) on superior condylar surface giving it a heart shaped appearance. Vertical depression was seen in the centre of head of condyle which gave it a appearance of double/bifid condyle and there was narrowing of the joint space. (Figure 3)

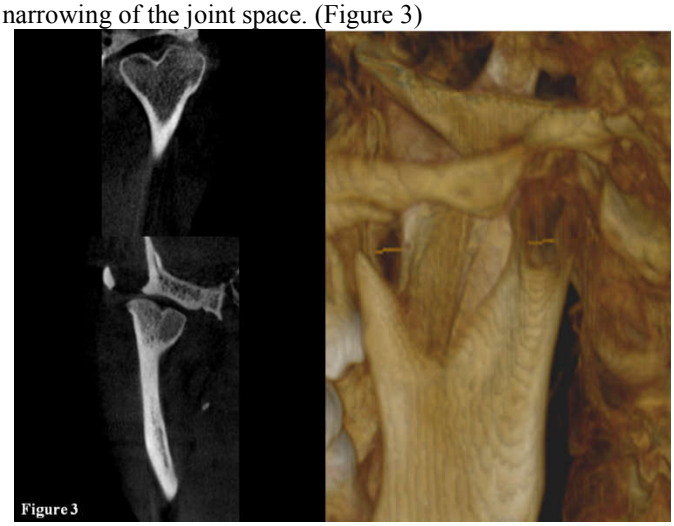

Figure 3 Bifid Condyle Depression (Notch) seen on superior condylar surface giving appearance of heart shape Condyle has a vertical depression in the center of the head as seen in lateral view gives appearance of double / Bifid condylar head.

Degenerative Disorders

Cone Beam Computed Tomography revealed a spectrum of appearances ranging from subchondral sclerosis and

osteophyte formation to extensive erosions. Small radiolucent areas with irregular margins surrounded by varying areas of increased density were visible deep to articulating surface- Ely's cysts. Bony proliferation was observes on lateral aspect of the condyle increasing the surface area. This new bone is called an osteophyte. There was enlarged glenoid fossa due to erosion. Altered condylar shape due to destruction and erosion of the condylar head was seen. (Figure 4)

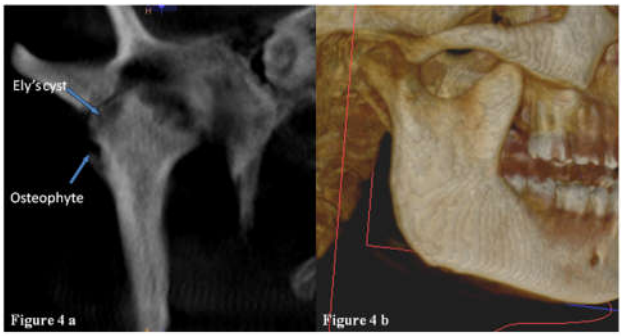

Figure 4a & 4b: Erosion of Condyle: Spectrum of appearances ranging from subchondral sclerosis & Osteophyte formation to extensive erosions narrowing of the joint space Small radiolucent area with irregular margin surrounded by varying area of increased density is visible deep to articulating surface- Ely's cyst Bony proliferation can be seen on lateral aspect of condyle increasing the surface area - this new bone is called an Osteophyte

Erosion of the condyle

This showed pencil shaped appearance of the condylar head due to erosion of the anterior and posterior condylar surfaces and there was flattening of the articular surfaces. (Figure 5)
TMJ subluxation: (Figure 6)

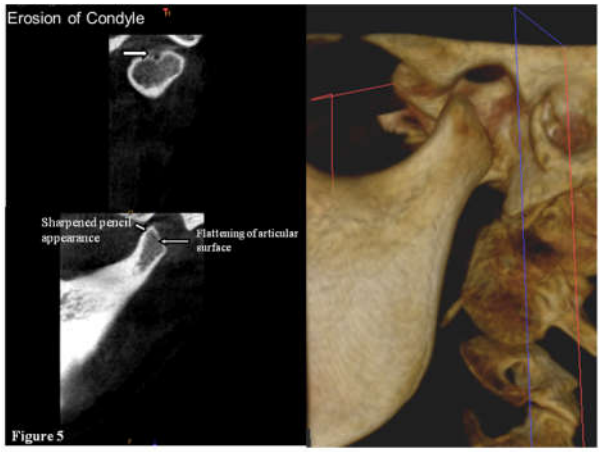

Figure 5 Erosion of Condyle: Sharpened pencil appearance (White arrow) of condylar head due erosion of the anterior & posterior condylar surfaces Flattening of articular surface Glenoid fossa is grossly enlarged due to erosion Condyle (White arrow) is altered in shape due to destruction & erosion of the condylar head.

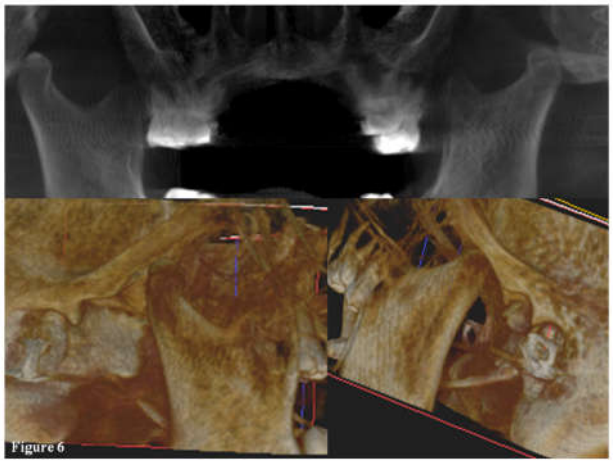

Figure 6 TMJ Subluxation (Hypermobility)

Traumatic Disorders

Temporomandibular Joint Fractures

Fractures of the temporomandibular joint are common due to trauma to the joint or direct impact to chin region leads to unilateral or bilateral sub condylar fracture. CBCT imaging reveled TMJ fractures at condylar neck which was often accompanied by dislocation of condylar head. Fractures were clearly seen at the sub condylar level with mediolateral displacement of the condyle which is difficult to diagnose in two dimensional radiographs due to superimposition of adjacent structures. (Figure 7)

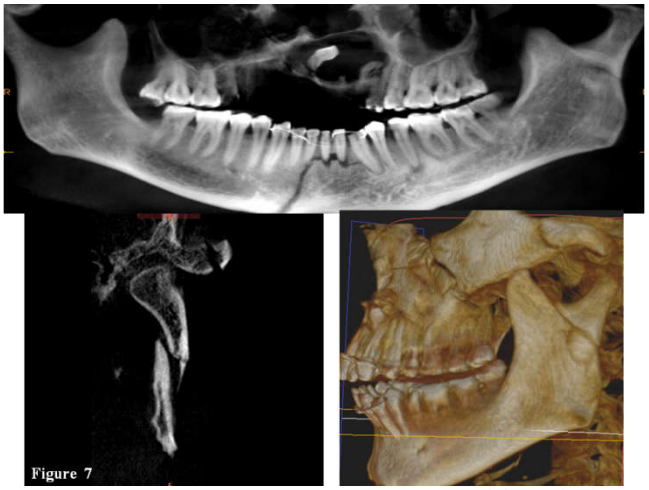

Figure 7 Fracture: TMJ Fractures common at condylar neck often accompanied by dislocation of condylar head Fracture can be seen at sub condylar level.

Malunited Fractured subcondyle (Figure 8)

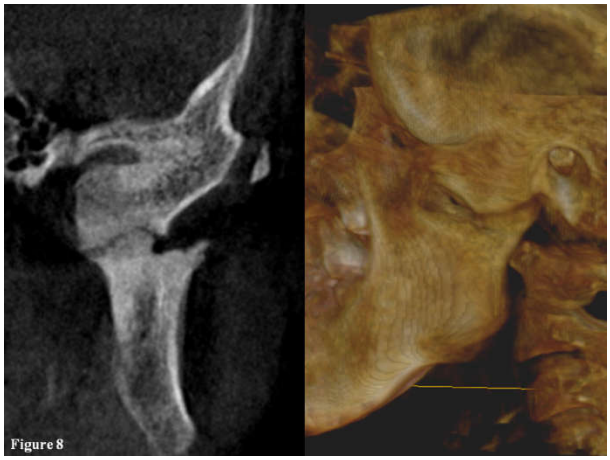

Figure 8 Malunited left TMJ

TMJ Ankylosis

Bony Ankylosis

The temporomandibular joint space was completely obliterated by an osseous bridge on right side and there was progressive elongation of the coronoid process. (Figure 9)

Figure 9 Fibrous Ankylosis: Articulating surface is irregular Joint space is narrow two irregular surfaces are appearing as to fit into one another like a jigsaw puzzle**.**

Fibrous Ankylosis

The images revealed irregular articulating surface and narrow joint space. Two irregular surfaces was appearing as to fit into one another like a jigsaw puzzle.

Benign Tumours

Osteoma of the condyle

CBCT findings revealed enlargement of the condyle with an irregular outline. There was bulbous expansion of the condyle. There was altered trabecular pattern with increased density due to new abnormal bone. (Figure 10)

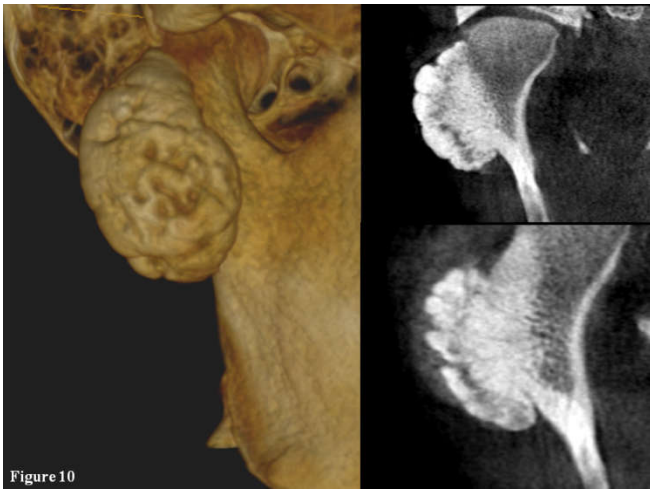

Figure 10 Benign Tumors: Osteoma of condyle Enlargement of condyle with an irregular outline bulbous expansion of the condyle, altered trabecular pattern increased density due to new abnormal bone formation with abnormal trabeculae.

DISCUSSION

This study attempted to list the temporomandibular joint disorders by CBCT imaging. It Included the developmental, degenerative, traumatic and benign tumors of the temporomandibular joint. The presence of bone changes of condylar hypoplasia, condylar hyperplasia, flattening, erosion, subchondral sclerosis, osteophyte formation, Elys cysts, fractures of TMJ, ankylosis and osteoma of condyle was studied.

The TMJ is rather a complex area to investigate radiographically. There are a number of imaging techniques for imaging the TMJ, but there is still no single technique that provides accurate imaging of all the components of the complex anatomy of the joint. The modern imaging modality such as MRI and CT scan is now being used more frequently for radiographic examination of the temporomandibular joint.
The TMJ which comprises the mandibular condyle, Glenoid fossa the inferior component and the temporal bone forming the superior component is one of the most complex joints in the body. The TMJ disorders are clinically manifested by craniofacial pain in muscles of mastication, limited mouth opening and clicking sound of TMJ in 60% of the population. Some type of TMJ disorders including myofascial dysfunction, internal derangement or degenerative joint disorder has been observed. CBCT provides accurate and reliable measurements in the dimensions of the mandible and the TMJ.

Osteoarthritis of the TMJ is an age - associated with degenerative changes seen in almost 40% of patients above the age of 40 years. It leads to bony changes in the TMJ like flattening, sclerosis, formation of osteophytes, erosion, resorption of the condylar head, mandibular fossa erosion and reduced joint space. Flattening (59%) and osteophyte (29%) are the most dominant degenerative changes seen on CBCT.[8]Many *in vitro* cadaveric studies have cited the importance of CBCT in evaluation of bony defects and osteophytes. Erosive changes in the TMJ are most effectively analysed using CBCT in the 6 inch FOV as compare to the 12 inch FOV.[9]Alexiou, *et al*. used CBCT to evaluate the degenerative changes and determined that patients in older age groups are expected to have more common and more severe bone changes than those in younger patients.[10]Alkhader, *et al.* performed a comparative study between CBCT and MRI.

According to their study CBCT is better than MRI in evaluation of changes in shape (flattening, osteophyte formation or erosion) rather than changes in size. They concluded that this was probably because MRI had inadequate spatial resolution and increased slice thickness (>3mm) in clinical use. Also other difficulties like presence of fibrous tissues inside the TMJ, proximity of lateral pterygoid muscle to the articular surface of the condyle and presence of air spaces in the temporal bone can hinder the accuracy in the analysis of MRI.[11] Though there is a poor correlation between condylar changes perceived on CBCT images and clinical signs and symptoms seen in patients with TMJ osteoarthritis (TMJOA).[12]

CBCT plays an key role in diagnosing initial stages of juvenile idiopathic arthritis (JIA) in children which, when undetected, may affect facial growth and development. Farronato, *et al*. concluded from their study that CBCT can be used to volumetrically measure the TMJ damage in these patients by assessing condylar and mandibular volumes.[13]

Condylar asymmetry is very common in children with JIA. Use of CBCT in TMJ imaging shows a wide range of condylar destruction patterns which could be minor erosions within the cortex to almost widespread distortion of the head of the condyle.[14]The TMJ is frequently involved in patients with multiple maxillofacial traumas. Here again in most cases neither medical CT nor Conventional dental radiography alone can report all the diagnostic challenges that are faced. CBCT enables us to meet the patient needs by providing ample

information regarding the pattern of fracture, its extent and relative locations of vital anatomic structures.[15]

The diagnostic accuracy of CBCT in detecting the degenerative disorders of TMJ is much greater than other imaging modalities. Its diagnostic properties in evaluating bony changes are much greater. So CBCT as imaging modality to analyze the osseous changes of the temporpmandibular joint is considered.

CONCLUSION

The purpose of this review is to summarize data on the study of temporomandibular joint disorders through CBCT images. From this study we conclude that:

A. CBCT 3D imaging allows calculation of volume and surface of mandibular condyle.
B. It improves the qualitative analysis of condylar surface and allows detecting mandibular condyle shape.
C. CBCT 3D imaging clarifies the optimal positioning of the condyle in the glenoid fossa.
D. It allows visualization of bone changes on the cortical surface.

It allows the comparison between the two condyles in case of facial asymmetry and the linear dimensions of the condyle.

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