Journal of Oral Medicine, Oral Surgery, Oral Pathology and Oral Radiology 2023;9(2):67–71

Content available at: https://www.ipinnovative.com/open-access-journals

Journal of Oral Medicine, Oral Surgery, Oral Pathology and Oral Radiology

Journal homepage: www.joooo.org

Review Article

Diagnostic efficacy of cone beam computed tomography in tmj disorders – A narrative review

Taseer Bashir[1,*], Mysore K Sunil[1], Arti Saluja[2], Alyaa Essam Senan[3], Mohammed Ahmed Abdulrahaman Albahi[3], Arpan Manna[1]

[1] *Dept. of Oral Medicine & Radiology, Teerthanker Mahaveer Dental College and Research Centre, Moradabad, Uttar Pradesh, India*
[2] *Dept. of Oral Medicine and Radiology, Sardar Patel Postgraduate Institute of Dental And Medical Sciences, Lucknow, Uttar Pradesh, India*
[3] *Batterjee Medical College, Jeddah, Saudi Arabia*

ARTICLE INFO

Article history:
Received 01-03-2023
Accepted 22-03-2023
Available online 02-06-2023

Keywords:
Temporomandibular joint disorder
Cone beam computed tomography
Temporomandibular joint imaging
Radiography
Dental imaging

ABSTRACT

Temporomandibular joint disorders (TMDs) diagnosis requires routine clinical evaluation and radiographic evaluation of patients with temporomandibular joint disorders (TMDs). Various imaging techniques have been described in the literature to evaluate TMJ in both symptomatic and asymptomatic patients. Cone beam computed tomography (CBCT), a fast developing method, is currently used often in dento-maxillofacial imaging. Due to its great resolution and relatively low dosage, it has an advantage. When looking through the data on TMJ imaging, it appears that the ongoing CBCT revolution has had a significant influence. The goal of this narrative review is to discuss the current situation regarding the diagnostic use of CBCT in TMDs.

This is an Open Access (OA) journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprint@ipinnovative.com

1. Introduction

A balance between the joint component, the muscle component, and the dental component is desired for the health of the masticatory system. Therefore, it is crucial to use radiography in conjunction with clinical evaluation to make the correct diagnosis of TMD. It will make it easier to develop a treatment plan that works. Imaging supports clinical findings, according to the 1992 revision of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD).[1]

The word "ginglymo-diarthrodial," which combines the terms "ginglymoid (rotation) and arthrodial," is used to describe TMJ (translation). Disorders of the temporomandibular joint can have a variety of etiological causes. Factors include muscle hyperactivity, degenerative, and inflammatory illnesses affect the stability of the TMJ. These ultimately have a significant impact on the emergence of diseases of the temporomandibular joint (TMD).[2]

TMDs can manifest in a variety of ways, such as with pain and soreness in and around the TMJ, such as in the pre-auricular region, with decreased mouth opening, or with a clicking sound during functional jaw movement.[3] Tinnitus, depression, hearing loss or impairment, ear plugging, earaches, trouble swallowing, and vertigo are a few more uncommon problems.[4]

Previous research has linked TMDs to abnormalities in the TMJ's soft and/or bony tissues.[5] Several methods, including panoramic radiography, transcranial radiography, magnetic resonance imaging (MRI), and, more recently, cone-beam computed tomography, can be used to assess the architecture of the TMJ (CBCT).[6]

* *Corresponding author*.
E-mail address: taseer.bashir@bmc.edu.sa (T. Bashir).

https://doi.org/10.18231/j.jooo.2023.015
2395-6186/© 2023 Innovative Publication, All rights reserved.

The limitations of standard radiography techniques are seen in cases where there are bony abnormalities within the TMJ. The radiographic evaluation is crucial to the diagnostic evaluation of a patient with TMD. The American Academy of Oral and Maxillofacial Radiology (AAOMR) has outlined the criteria for choosing an image for diagnosis, determining a course of therapy, and establishing a protocol for relevant follow-up for TMD patients.[7]

Due to anatomical structural overlap, osseous abnormalities such as osteophytes, erosions, and pneumatization of articular eminence are difficult to see on standard radiographs. This recommends and necessitates the employment of cutting-edge imaging modalities including arthrography, MRI, computed tomography (CT), and most recently, cone beam computed tomography (CBCT).[8]

The introduction of CBCT is a relatively new development in a field of clinically oriented CT technologies that is constantly increasing. At Mayo Clinic, the first CBCT scanner prototype was put to service in 1982. According to the current report, a number of CBCT systems have developed and are currently widely utilised for medical imaging.[9] For the evaluation of osseous abnormalities in the TMJ, CBCT is regarded as a trustworthy diagnostic imaging method.[10] Digital CBCT is as accurate as computed tomography (CT), but it exposes patients to less radiation, making it the preferred method over traditional CT.[11] The doctor can check for osseous abnormalities in the TMJ using CBCT imaging, including osteophytes, erosion, flattening, subchondral bone sclerosis, ankylosis, and pseudocysts.[12]

Previous studies did find some structural damage in TMJ in some patients without TMDs.Therefore, there is a need to understand the importance of radiographic imaging and its correlation to TMD-related complaints.[13]

2. Literature Review

Via 1988 to 2014, 256 publications were retrieved from a thorough data search in the PubMed and Google Scholar databases using the following search terms: temporomandibular joint dysfunction, cone beam computed tomography, temporomandibular joint imaging, radiography, and dental imaging. According to the parameters of the present review, a total of 32 papers were chosen and examined.

For the effective use of diverse imaging techniques such panoramic radiography, plain radiography, conventional and computed tomography, arthrography, and MRI, Fryback and Thornbury[14] presented a six-level hierarchical model in 1991. All these imaging techniques are being practised with varying frequency in clinical practice to image TMJ. Unfortunately, all these imaging techniques have some kind of shortcomings in effectively visualizing the TMJ anatomy. Hence it is crucial and important to understand the accuracy and reliability of each imaging modality as it affects and determines the choice of treatment and prognosis of TMD patients.

Panoramic radiography is one of the most well-liked and often utilized imaging modalities for the facial region. Getting panoramic imaging of the TMJ is rather easy. Its low-grade sensitivity for osseous changes of the mandibular condyle is a disadvantage that significantly reduces its diagnostic accuracy and dependability. All that can be seen on conventional radiographs of the TMJ are its mineralized structures. These are impacted by a number of neighboring structures that are superimposed, which makes visibility challenging. They were disqualified from consideration in the RDC/TMD validation technique due to their restricted TMJ imaging range.[14]

According to the RDC/TMD validation protocol, Ahmed and Hollender in 2009[15] suggested the use of CT since it is more effective than other imaging modalities at identifying osseous abnormalities within the TMJ.

According to a comprehensive review by Hussain et al. from 2008,[16] axially corrected tomography is the preferred imaging method for identifying erosions and osteophytes in the TMJ.

The usage of medical grade CT is largely restricted to hospital settings owing to its high equipment setup infrastructure cost and radiation dosage. Regarding TMJ Imaging, enormous amount of literature is available and being published in recent times as CBCT has inspired and fueled this research related to TMJ imaging.

Tecco and Saccucci et al in 2010[17] studied condylar volume and surface in caucasian young adult subjects and reported that the CBCT imaging of TMJ allows accurate measurements of both surface and volume of condylar element. These findings help in treating patients with TMJ disorders.

Osteoarthritis is viewed as a degenerative condition that worsens with age. Nearly 40% of patients over the age of 40 experience it. It is characterised by osseous changes in the TMJ, including flattening, osteophytes, sclerosis, erosion of the mandibular fossa, erosion, resorption of the condylar head, and loss of joint space.

The two most common degenerative alterations in the TMJ as seen on CBCT were flattening (59%) and osteophyte (29%), according to Pontual and Freire et al. in 2012.[18]

Numerous in-vitro studies have been conducted to examine the role of CBCT in identifying osseous anomalies and osteophytes in cadaveric TMJ. According to Librizzi and Tadinada et al., using a 6-inch FOV in CBCT rather than a 12-inch FOV is more useful for diagnosing the erosive changes in the TMJ in 2011.[19]

Using CBCT imaging, Alexiou et al. revealed in 2009[20] that the degenerative alterations in the TMJ get worse with age.

In 2010, Alkhader et al.[21] performed a comparison of CBCT and MRI. According to their findings, CBCT is preferable to MRI for detecting abnormalities such osteophytes, flattening, or erosion as opposed to size changes. In clinical applications, MRI has a reduced spatial resolution and a greater slice thickness (>3mm). The accuracy of MRIs is impacted by the presence of fibrous structures in the TMJ, near proximity of the lateral pterygoid muscle to the articulating condyle, and air spaces within the temporal bone.

According to Palconet and Ludlow in 2012,[22] there is little association between CBCT-based radiographic imaging and clinical signs and symptoms in individuals with TMJ osteoarthritis.

Early juvenile idiopathic arthritis (JIA) diagnosis in children is aided by CBCT imaging. If circumstances go unnoticed, this may influence facial development and cause growth deviations.

In order to volumetrically measure the TMJ damage in TMDs, Farronato and Garagiola et al.[23] investigated the use of CBCT for quantifying the condylar and mandibular volumes.

Children with juvenile idiopathic arthritis were investigated by Huntjens and Wouters in 2008,[24] specifically condylar asymmetries (JIA). They claimed that CBCT revealed a variety of condylar damage patterns, from minor cortical erosions to full condylar head deformity.

Palomo et al. in 2009[25] described a multiple maxillofacial fracture scenario, similar to Le forte III, and noted that, in most situations, neither conventional dental radiography nor medical CT alone can resolve all diagnostic difficulties. The use of CBCT in this situation helps to reveal pertinent details on the type of fracture, its extension, and the location of significant anatomic landmarks.

Children with TMJ dysfunction were the subject of a study by Sanchez Woodworth et al. in 1988[26] using arthrography, computed tomography (CT), and magnetic resonance imaging (MR) of one or both joints. They discovered that 85% of patients exhibited TMJ changes. Wiberg and Wänman in 1998[27] used TMJ tomography in young patients with signs and symptoms of temporomandibular disorders and found a high prevalence of 66% with temporomandibular joint alteration.

Price et al. in 2012[28] reported the incidental findings of TMDs to be 15.4% using in CBCT imaging.

TMJ changes made for 12.6% of all incidental findings in this group of 427 orthodontic patients, according to Edwards et al 2014[29] research on CBCT pictures of these individuals.

The prevalence rate of TMJ changes in CBCT pictures of dental implant patients ranged from 3.9% to 6.2%, according to Pette and Norkin et al 2012[30] analysis of incidental findings from a retrospective study of 318 cone beam computed tomography consultation reports.[31]

The articular fossa and condyle characteristics of people with TMD problems were examined by Okur et al. using CT of the temporomandibular joint. They found no obvious difference between the joint spaces of the two groups (asymptomatic group). Osteophytes were seen 14% of the time in CBCT pictures of TMD patients, according to Alkhader et al. in 2010.[21]

In their study, Palconet and Ludlow in 2012[22] found little connection between the structural alterations seen on CBCT images and the clinical symptoms and indicators of TMJ problems. Lee et al in 2012[32] in their study on 212 TM joints found that CBCT was able to detect more percentage of erosion compared with OPG. CBCT was able to detect 2.1% of osteophytes whereas OPG detected only 0.9% and hence proving that CBCT is superior to OPG.

Another study done by LeResche (1997)[33] found that pain in the temporomandibular joint is twice as common in females as in males.

3. Future Considerations

Imaging is regarded as a crucial diagnostic aide to the clinical evaluation.[34] No innovation or piece of technology is exempt from criticism, and CBCT is no different. On a few occasions, it has drawn criticism. The use of CBCT in the investigation of sinus, middle and inner ear implant, and dento-maxillofacial imaging is among the most extensively studied topics in head and neck imaging.[9] The amount of study into TMJ imaging has increased dramatically. Even however, exploratory research has not yet been able to prove CBCT's superiority to other TMJ imaging modalities and support its therapeutic use through thorough clinical and prospective reviews.

4. Limitations of CBCT

The metal artefacts are lessened in more recent CBCT scanners with integrated FPD. However, the movement artefacts are still present and are a cause for concern. The distortion of the Hounsfield Units (HU) is another area of concern, hence CBCT cannot be used to estimate bone density. CBCT has a benefit because to the minimal radiation exposure to the patient. However, no such consensus regarding the radiation detector setup in phantoms for the CBCT dosimetry measurement has been developed as of yet. The majority of CBCT studies that have been published do not give enough details about the radiation dose, image quality, or CBCT equipment parameters. The ability of CBCT to see inside soft tissue is limited.[2] Hence the role of CBCT in TMJ disc derangements is under question. Currently, CBCT has been largely adopted as a dental office-based diagnostic imaging technique. CBCT imaging in TMD's assist in diagnosis and treatment planning but enthusiastic overuse of CBCT and patient safety must be taken into consideration.

5. Conclusion

Finding information about TMJ imaging reveals that the anatomy and physiology of the TMJ can be evaluated using a variety of radiographic techniques. Due to the superimposition of nearby structures and morphological differences, it is a region that is typically regarded as being challenging for imaging. To effectively manage the patient, however, the complexity of the TMD necessitates detailed and exact imaging of the area. Due to its low radiation dose to the patient, minimal setup equipment requirements, and special capacity to produce multiplanar reformation and 3D images, CBCT clearly has an edge over other imaging procedures. The use of CBCT in TMJ imaging has been the subject of promising studies. However, more systematic clinical studies, adequate training of the personnel and a complete understanding of the anatomical and functional dynamics of the TMJ are essential to harness the very true potential of this breakthrough technology.

According to prior research, patients with TMDs have a significant prevalence of bone abnormalities that can be seen on CBCT imaging. On CBCT pictures, it can be shown that the prevalence of different TMJ derangements was similar in both symptomatic patients with TMJ disease and those who had no symptoms. It demonstrates that a small number of people who have TMJ structural impairment may not exhibit it clinically. As a result, it is recommended as a conclusion that routine CBCT imaging be used in dentistry together with careful attention to clinical examination to detect this problem (TMD build-up) in its early stages.

6. Source of Funding

None.

7. Conflict of Interest

None declared.

References

1. Dworkin SF, Resche L. Research diagnostic criteria for temporomandibular disorders: Review criteria, examinations and specifications, critique. *J Craniomandib Disord*. 1992;6(4):301–55.
2. Herb K, Cho S, Stiles MA. Temporomandibular joint pain and dysfunction. *Curr Pain Headache Rep*. 2006;10:408–14.
3. Lee HS, Baek HS, Song DS, Kim HC, Kim HG, Kim BJ, et al. Effect of simultaneous therapy of arthrocentesis and occlusal splints on temporomandibular disorders: anterior disc displacement without reduction. *J Korean Assoc Oral Maxillofac Surg*. 2013;39(1):14–20.
4. Springer SP, Greenberg SM, Glick M. Temporomandibular disorders. In: Greenberg SM, Glick M, editors. Burket's Oral Medicine Diagnosis and Treatment. Ontario, Canada: BC Decker; 2003. p. 230–2.
5. Larheim TA. Role of magnetic resonance imaging in the clinical diagnosis of the temporomandibular joint. *Cells Tissues Organs*. 2005;180(1):6–21.
6. Gupta R, Grasruck M, Suess C, Bartling SH, Schmidt B, Stierstorfer K, et al. Ultra-high resolution flat-panel volume CT: Fundamental principles, design architecture and system characterization. *Eur Radiol*. 2006;16(6):1191–205.
7. Miracle AC, Mukherji SK. Cone-beam CT of the head and neck, part 1: Physical principles. *AJNR Am J Neuroradiol*. 2009;30(6):1088–95.
8. Vos WD, Casselman J, Swennen G. Cone-beam computerized tomography (CBCT) imaging of the oral and maxillofacial region: A systematic review of the literature. *Int J Oral Maxillofac Surg*. 2009;38(6):609–25.
9. Dahlstrom L, Lindvall AM. Assessment of temporomandibular joint disease by panoramic radiography: reliability and validity in relation to tomography. *Dentomaxillofac Radiol*. 1996;25(4):197–201.
10. Shetty US, Burde KN, Naikmasur VG, Sattur AP. Assessment of condylar changes in patients with temporo-mandibular joint pain using digital volumetric tomography. *Radiol Res Pract*. 2014;2014:106059. doi:10.1155/2014/106059.
11. Zain-Alabdeen EH, Alsadhan RI. A comparative study of accuracy of detection of surface osseous changes in the temporomandibular joint using multidetector CT and cone beam CT. *Dentomaxillofac Radiol*. 2012;41(3):185–91.
12. Scarfe WC, Farman AG. Cone Beam Computed Tomography: A paradigm shift for clinical dentistry. *J Aust Dent Pract*. 2007;p. 92–100.
13. Caglayan F, Tozoglu U. Incidental findings in the maxillofacial region detected by cone beam CT. *Diagn Interv Radiol*. 2012;18(2):159–63.
14. Fryback DG, Thornbury JR. The efficacy of diagnostic imaging. *Med Decis Making*. 1991;11(2):88–94.
15. Ahmad M, Hollender L, Anderson Q, Kartha K, Ohrbach RK, Truelove EL, et al. Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD): Development of Image Analysis Criteria and Examiner Reliability for Image Analysis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2009;107(6):844–60.
16. Hussain AM, Packota G, Major PW, Flores-Mir C. Role of different imaging modalities in assessment of temporomandibular joint erosions and osteophytes: A systematic review. *Dentomaxillofac Radiol*. 2008;37(2):63–71.
17. Tecco S, Saccucci M, Nucera R. Condylar volume and surface in Caucasian young adult subjects. *BMC Med Imaging*. 2010;31:10–28.
18. Pontual MLA, Freire JSL, Barbosa JMN, Frazão MAG, Pontual AA. Evaluation of bone changes in the temporomandibular joint using cone beam CT. *Dentomaxillofac Radiol*. 2012;41(1):24–9.
19. Librizzi ZT, Tadinada AS, Valiyaparambil JV, Lurie AG, Mallya SM. Cone-beam computed tomography to detect erosions of the temporomandibular joint: Effect of field of view and voxel size on diagnostic efficacy and effective dose. *Am J Orthod Dentofacial Orthop*. 2011;140(1):25–30.
20. Alexiou K, Stamatakis H, Tsiklakis K. Evaluation of the severity of temporomandibular joint osteoarthritic changes related to age using cone beam computed tomography. *Dentomaxillofac Radiol*. 2009;38(3):141–7.
21. Alkhader M, Ohbayashi N, Tetsumura A, Nakamura S, Okochi K, Momin MA, et al. Diagnostic performance of magnetic resonance imaging for detecting osseous abnormalities of the temporomandibular joint and its correlation with cone beam computed tomography. *Dentomaxillofac Radiol*. 2010;39(5):270–6.
22. Palconet G, Ludlow JB, Tyndall DA, Lim PF. Correlating cone beam computed tomography results with temporomandibular joint pain of osteoarthritic origin. *Dentomaxillofac Radiol*. 2012;41(2):126–30.
23. Farronato G, Garagiola U, Carletti V, Cressoni P, Mercatali L, Farronato D. Change in condylar and mandibular morphology in juvenile idiopathic arthritis: Cone Beam volumetric imaging. *Minerva Stomatol*. 2010;59(10):519–34.
24. Huntjens E, Kiss G, Wouters C, Carels C. Condylar asymmetry in children with juvenile idiopathic arthritis assessed by cone-beam computed tomography. *Eur J Orthod*. 2008;30(6):545–51.
25. Palomo L, Palomo JM. Cone beam CT for diagnosis and treatment planning in trauma cases. *Dent Clin North Am*. 2009;53(4):717–27.
26. Sanchez RE, Katzberg RW, Tallents RH, Guay JA. Radiographic assessment of temporo-mandibular joint pain and dysfunction in the pediatric age-group. *ASDC J Dent Child*. 1988;55(4):278–81.
27. Wiberg B, Wänman A. Signs of osteoarthrosis of the temporomandibular joints in young patients: a clinical and

radiographic study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 1998;86(2):158–64.

28. Price JB, Thaw KL, Tyndall DA, Tyndall DA, Ludlow JB, Padilla RJ, et al. Incidental findings from cone beam computed tomogra-phy of the maxillofacial region: a descriptive retrospective study. *Clin Oral Implants Res*. 2012;23(11):1261–8.
29. Edwards R, Alsufyani N, Heo G, Flores-Mir C. The frequency and nature of incidental findings in large-field cone beam computed tomography scans of orthodontic sample. *Prog Orthod*. 2014;15:37. doi:10.1186/s40510-014-0037-x.
30. Pette GA, Norkin FJ, Ganeles J, Hardigan P, Lask E, Zfaz S, et al. Incidental findings from a retrospective study of 318 cone beam computed tomography consulta-tion reports. *Int J Oral Maxillofac Implants*. 2012;27(3):595–603.
31. Reddy A, Vincent SD, Hellstein JW. Incidental findings on cone beam computed tomography images. *Int J Dent*. 2012;2012:871532. doi:10.1155/2012/871532.
32. Lee DY, Kim YJ, Song YH, Lee NH, Lim YK, Kang ST, et al. Comparison of bony changes between panoramic radiograph and cone beam computed tomographic images in patients with temporomandibular joint disorders. *Korean J Orthod*. 2010;40(6):364–72.
33. Resche L. Epidemiology of temporomandibular disorders: implications for the investigation of etiologic factors. *Crit Rev Oral Biol Med*. 1997;8(3):291–305.
34. Scarfe WC, Farman AG. What is cone-Beam CT and how does it work? *Dent Clin North Am*. 2008;52(4):707–30.

Author biography

Taseer Bashir, PhD Student

Mysore K Sunil, Professor and Head

Arti Saluja, Reader

Alyaa Essam Senan, Student

Mohammed Ahmed Abdulrahaman Albahi, Student

Arpan Manna, MDS

Cite this article: Bashir T, Sunil MK, Saluja A, Senan AE, Albahi MAA, Manna A. Diagnostic efficacy of cone beam computed tomography in tmj disorders – A narrative review. *J Oral Med, Oral Surg, Oral Pathol, Oral Radiol* 2023;9(2):67-71.