An Assessment of Sagittal Condylar Position of TMJ Dysfunction in Centric Occlusion by Using Cone Beam Computed Tomography

Lamia H. Al-Nakib, B.D.S, M.Sc. [(1)]
Ako Omer Abdullah,B.D.S., M.Sc. [(2)]
Saeed A.Abd Al-Kareem, B.D.S., M.Sc. [(3)]
Sangar Hamid Ali, B.D.S., M.Sc. [(4)]

ABSTRACT

Background: Temporomandibular joint (TMJ) is a compound articulation formed from the articular surfaces of the temporal bone and the mandibular condyle.CBCT imaging of TMJ is that it allows accurate measurements of the volume and surface of the condyle. The aim of the study is to assess the sagittal position of mandibular condyle in patients with temporomandibulardysfunction using Cone Beam Computed Tomography in centric occlusion.

Materials and Methods: CBCT images for all patients were obtained in an upright position using New Tom Giano CBCT with different field of view (11 x 8), (11 x 5), and (8 x 8) and exposure factors was changed accordingly using NNT version 5.1 software for sagittal reconstruction, anterior, superior and posterior joint spaces was measured.

Results: There was a significant change in the anterior, posterior and superior joint spaces when compared to normal functioning TMJ. The sagittal position of the condyle in glenoid fossa could be affected by TMJ dysfunction and it would be positioned centrally but slightly inferior to the normal position according to the results of this study. There was no significant difference in the sagittal condylar position in glenoid fossa between sexes. There was significant difference in the value of anterior, posterior and superior TMJ spaces between right and left sides of the mandible in both normal cases and TMJD.

Conclusion: Sagittal section of Temporomandibular joint revealed that TMJ dysfunction affects the joint spaces in sagittal plane. It means significant changes occur in the value of anterior, posterior and superior joint spaces when compared to normal functioning TMJ.

Keywords: Condylar Position, TMJ Dysfunction Cone Beam Computed Tomography. (J Bagh Coll Dentistry 2016; 28(2):58-62).

INTRODUCTION

Temporomandibular joint (TMJ) is one of the complex joints of the body which comprises the mandibular condyle, and the temporal bone forming the superior component of the joint [(1)]. The articular eminence is a part of the temporal bone on which the condylar process slides during mandibular movements [(2)]. An articular disk is interposed between the temporal bone and the mandible, dividing the joint space into two components, i.e. an upper one in which gliding movements occur, and a lower one characterized by rotation or hinge movements. Temporomandibular joint is morphologically structured to support the specialized functional demands of mastication[(3)]. A fundamental question in dentistry is what to be regarded as the optimal position of the condyle in the glenoid fossa when the teeth are in maximum intercuspation [(4)].

The optimal condylar position in the glenoid fossa can be determined by the dimension of the joint space. Radiographically the joint space is a total term that is used for the description of the radiolucent zone that is placed between condylar and temporal parts [(5)].

Standard radiographic studies of the temporomandibular joint (TMJ), such as the plain film radiography and panoramic radiography, have little capacity to reveal anything more than gross osseous changes within the joint [(6)].

The use of conventional radiographs has inherent limitations such as structural superimpositions in two-dimensional imaging, particularly in the region of the petrous temporal bone, the mastoid process, and the articular eminence, which indeed limits an accurate view of the TMJ [(7)].

Even conventional CT was used for TMJ evaluation and it was with reasonable results [(8)] but CT is performed with the patient in the supine position, rather than in the upright position, which may have led to errors in the evaluation of the condyle-fossa relationships [(9)]. The high cost, access to equipment, motion artifact and the relatively high radiation dose have limited the widespread use of CT for TMJ evaluation [(10)].While Magnetic Resonance Imaging (MRI) is

(1)Professor, Department of Oral Diagnosis, College of Dentistry/ University of Baghdad.
(2)Specialist Dentist, Sulaimania Directory of Health, Ministry of Health in Kurdistan rejoin.
(3) Assistant Professor, Department of Oral Diagnosis, School of Dentistry, Faculty of Medical Sciences/University of Sulaimania.
(4) Specialist Dentist, Khanzad Teaching center/ Erbil,Ministry of Health in Kurdistan rejoin.

considered as one of the most useful tools that shows disc displacement. Unfortunately, MRI gives little information of the bone TMJ structures [5].

Cone Beam Computed Tomography (CBCT) for dental and maxillofacial diagnostic osseous tasks has been developed as an alternative to conventional CT, the results of CBCT technology in images of CT-like quality were obtained on the basis of less expensive equipment and components, shorter patient examination time and much lower radiation dose than required for conventional CT. In addition, the scanning procedure of the patient and the software for image reconstruction connected with CBCT are very user-friendly [11].

Cone Beam Computed Tomography is similar to conventional CT in diagnosing different osseous conditions and that it provides a cost- and dose effective diagnostic options [12].

A large body of literatures has been published recently about CBCT in Temporomandibular joint imaging due to the fact that CBCT has inspired research in TMJ imaging. An important advantage of CBCT imaging of TMJ is that it allows accurate measurements of the volume and surface of the condyle. These measurements are extremely advantageous in the clinical practice when treating patients with TMJ dysfunctions [13].

Many in vitro cadaveric studies have explored the role of CBCT in assessing bony defects and osteophytes. Erosive changes in the TMJ are most effectively diagnosed using CBCT in the 6 inch FOV as compared to the 12 inch FOV[14].

Alkhader et al.[15]performed a comparative study between CBCT and MRI and it was revealed that CBCT is better than MRI in detecting changes in shape (flattening, osteophyte formation or erosion) rather than changes in size, however there is a poor correlation between condylar changes observed on CBCT images and clinical signs and symptoms seen in patients with TMJ osteoarthritis (OA), CBCT plays an important role in diagnosing early stages of juvenile idiopathic arthritis (JIA) in children which, when undetected, can damage facial development and cause growth alterations.

Farronato et al.[16]concluded from their study that CBCT can be used to volumetrically quantify the TMJ damage in these patients by measuring condylar and mandibular volumes.

MATERIALS AND METHODS

After approval of scientific Ethical committee/School of Dentistry at Sulaimany University a cross-sectional study carried out on thirty-two patients attending Oral and Maxillofacial Department of Dental center in Erbil city from February to June 2014. (All patients were between 20 to 35 years old).

Patients were classified into two groups, Control group: 32 joints of 16 patients (8 males and 8 females) attending Denta center for different purposes other than TMJ problems and TMJD group: 32 joint of 16 patients with pre diagnosed to have TMJ dysfunction by Oral medicine specialist (8 males and 8 females).

CBCT images for all patients were obtained in an upright position using New Tom Giano CBCT with different field of view (11 x 8), (11 x 5), and (8 x 8) and exposure factors will be change accordingly using NNT version 5.1 software for sagittal reconstruction.

At the beginning, on axial slices, the cut that showed the largest medio-lateral dimension of condylar heads was selected (Figure 1).

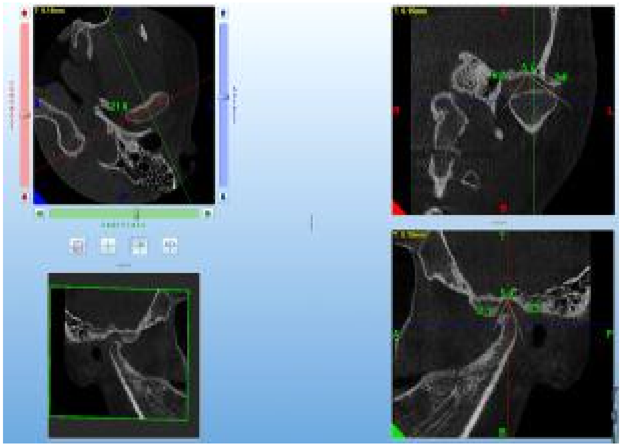

Figure 1: Largest medio-lateral dimension of condylar head on axial slice

Next, true sagittal images with 0.15 mm thickness and interval distance on medio-lateral axis of condyle were reconstructed then, two true central sagittal images with 0.15 mm thickness and interval distance were chosen. After that, anterior, superior and posterior joint spaces were measured on these reconstructed sagittal images. Initially, a horizontal line on uppermost area of glenoid fossa was drawn and the intersection of this line with glenoid fossa was selected as superior reference point (S), sequentially, this point was connected to the most prominent points on anterior (A) and posterior (P) aspects of the condyle. Finally, the perpendicular distance from A and P tangent points to glenoid fossa was measured as anterior and posterior joint spaces (AJS, PJS), The right distance between S point and superior prominent point of condylar head were considered as superior joint space (Sjs). An NNT version 5.1 software was used for sagittal reconstruction and measurements (Figure 2).

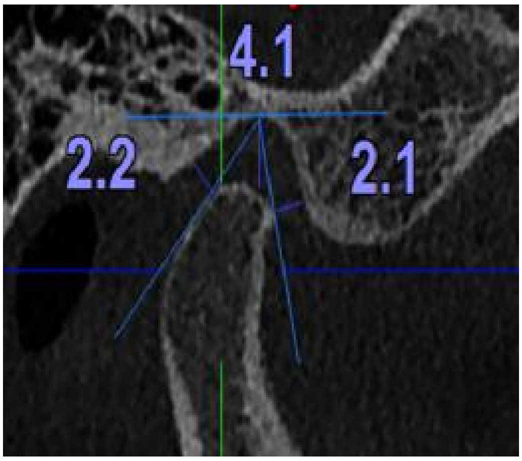

Figure 3: Measurement of superior, anterior and posterior joint spaces for male patient with TMJD

RESULTS

Thirty two patients were participated in this study (16 males and 16 females) and were divided into two groups, control and TMJD group

The mean age ± SD of control group was 28.7 ± 3.6 years and that of (Temporo-mandibular joint dysfunction) TMJD group was 29.3 ± 4.4 years with similar sex distribution**.**

There was a significant difference between TMJD group and control group (all three spaces were presented to be larger in TMJD group than control group, $P<0.01$ and $P<0.05$ in both sides (Table 1), but a non-significant difference in both sexes when a comparison of temporomandibular joint spaces (AJS, PJS, and SJS) in control and TMJD groups were assessed ($P>0.05$).

Table 2 shows the mean ± SD of the right and left temporomandibular joint space in control group. Right AJS was significantly higher than left AJS while the left PJS and SJS were significantly higher than the right PJS and SJS, $P<0.01$ and $P<0.05$.

Table 3 shows the mean ± SD of the right and left temporomandibular joint space in TMJD group. The right AJS was significantly higher than the left AJS, however the left PJS and SJS were significantly higher than the right PJS and SJS, $P<0.05$ and $P<0.01$ respectively.

Table 1: Right and left temporo-mandibular joint spaces in control and TMJD groups

TM Joint space	Control Mean ± SD	TMJD Mean ± SD	P value
Right AJS	2.36 ± 0.31	2.61 ±0.24	0.016
Left AJS	2.01 ± 0.26	2.24 ± 0.16	0.005
Right PJS	2.00 ± 0.12	2.18 ± 0.19	0.003
Left PJS	2.21 ± 0.18	2.35 ± 0.20	0.046
Right SJS	2.43 ± 0.17	3.57 ± 0.27	0.001
Left SJS	2.79 ± 0.41	3.85 ± 0.31	0.001

Table 2: Right and left temporomandibular joint spaces in control group

TM Joint space	Right	Left	P value
AJS	2.36 ± 0.31	2.01 ± 0.26	0.028
PJS	2.00 ± 0.12	2.21 ± 0.18	0.001
SJS	2.43 ± 0.17	2.79 ± 0.41	0.037

Table 3: Right and left temporomandibular joint spaces in TMJD groups

TM Joint space	Right	Left	P value
AJS	2.61 ± 0.42	2.24 ± 0.16	0.035
PJS	2.18 ± 0.19	2.35 ± 0.20	0.019
SJS	3.57 ± 0.27	3.85 ± 0.31	0.001

DISCUSSION

In the current study, the value of SJS was the greatest among TMJ spaces followed by AJS and PJS in both sexes in control and TMJD groups. This result is in agreement with Dalili et al. [5] and Ikeda and Kawamura[4]but is incompatible with Hansson et al. [17] who directly measured disc thickness in autopsy materials and found that the thickness of the posterior and anterior bands was more than that of the intermediate zone. In addition, the significant difference in the thickness of intermediate joint space can be due to ignoring the thickness of the soft tissues covering the fossa.

The results obtained in the present study revealed that the values of AJS, PJS, and SJS were greater in TMJD group than in the control group**,** all the three spaces were larger in TMJ dysfunction which means in the centric position of mandible in patients with TMJ dysfunction the head of the condyle in the glenoid fossa is positioned more centrally and inferiorly when compared to normal subjects (centrally and slight inferior position is more common than other positions). The results of Wiese et al. [18]and Dalili et al. [5]studies were similar to the present results, that the condyle was positioned centrally in most TMJs. But the results are in agreement with Incesu et al. who reported the posterior position of condyle as the most common position in patients with temporomandibular joint disorder.

Sicher et al. [19]wrote that, in all synovial joints in the human body, the articulating surfaces of the opposing bones are kept in firm contact by the associated ligaments and musculature, and that firm contact is maintained with the disc closely fitted between the opposing articular surfaces throughout the range of jaw movement. If this close relationship between the eminence and the condyle is lost due to disc displacement, there should be changes in joint space. The present study included joints with no signs of TMD which were considered as normal samples based only on radiographic and chair-side examinations, and cases having TMD by using pain, joint sound, tenderness of joint area and limitation of mouth opening leaving the possibility of undetected disc displacements. In addition, the normalcy of disc position in a static mandibular position does not ensure its functional normalcy. The older age range of the subjects might be associated with an increased risk of disc displacement and morphologic changes in joint structures.

Gateno et al.[20] found that in patients with anterior disc displacement, the position of the condylar head was significantly different than in patients with normal joints in which condylar heads in patients with anterior disc displacement were positioned more posteriorly and superiorly within the fossa than in patients with normal joints. However, there is one author who reported no difference in condylar position between ADD joints and normal joints[21].

According to the present result, there is no significant difference in the value of AJS, PJS and SJS between sexes and this result is in agreement with Ikeda and Kawamura[4]and in agreement with Dalili et al. [5], who found that SJS showed statistically significant difference between the genders using limited CBCT. It is also incompatible with Kinniburgh et al. [22]who used the conventional tomography, and this different result may be because of the difference in the population that they took their samples from, compared to the sample of this study which was taken from Kurdish population.

In the control group, the value of right AJS was greater than the left side. The left PJS and SJS were significantly higher than the right PJS and SJS. This result was the same for TMJD group. This result is in agreement with Dalili et al. [5]. Significant differences between the values of AJA, PJS and SJS in right and left sides were observed in the study by Dalili et al.[5].Previous studies concluded that asymmetric TMJ spaces were usually associated with TMJ dysfunction conversely; bilateral condylar concentricity was associated with an absence of clinical symptoms. Moreover, questions have not been clearly answered regarding the potential of any differences in patients with or without symmetry as to the right-sided or left-sided condylar positioning or deviated or non-deviated sides, as well as how much of a difference between the right and left sides exists [9].

Kim et al. [9]investigated whether the condylar-fossa relation is bilaterally symmetrical in class III patients with or without asymmetry, compared to that of the subjects with normal occlusion and found that the condylar spaces of AJS, SJS, and PJS were not significantly different whether the patient had a class III malocclusion or class I normal occlusion and whether the patient had symmetry or asymmetry. This result showed that the TMJ spaces were not significantly different regardless the presence of asymmetry.

REFERENCES

1. Shahidi S, Vojdani M, Paknhad M. Correlation between articular eminence steepness measured with cone-beam computed tomography and clinical dysfunction index in patients with temporomandibular joint dysfunction. Oral Surg Oral Med Oral Pathol Oral Radiol 2013; 116(1): 91-7.
2. Sumbullu MA, Caglayan F, Akgul HM, Yilmaz AB. Radiological examination of the articular eminence morphology using cone beam CT. DentomaxillofacRadiol 2012;41: 234–40.
3. Mastumoto M, Bolognese A. Study of Radiographic Morphology of the Temporomandibular Joint. Braz Dent J1993;4(2): 97-103.
4. Ikeda K, Kawamura A. Assessment of optimal condylar position with limited cone-beam computed tomography. Am J Orthod Dentofac Orthop 2009; 135(4):495-501.
5. Dalili Z, Khaki N, Kia SJ, Salamat F. Assessing joint space and condylar position in the people with normal function of temporomandibular joint with cone-beam computed tomography. Dental Res J 2012; 9(5):607-12.
6. Schlueter B, Kim KB, Oliver D, Sortiropoulos G. Cone Beam Computed Tomography 3D Reconstruction of the Mandibular Condyle. Angle Orthod2008; 78(5):880-8.
7. Arieta-Miranda JM,Silva-Valencia M, Flores-Mir C, Paredes-Sampen NA, Arriola-Guillen LE. Spatial analysis of condyle position according to sagittal

skeletal relationship, assessed by cone beam computed tomography. ProgOrthod 2013; 18(1):36.
8. Abdul-Nabi LA, Al-Nakib LH. Flattening of the posterior slope of the articular eminence of completely edentulous patients compared to patients with maintained occlusion in relation to age using computed tomography. JBaghColl Dentistry 2015; 27(2): 66-71.
9. Kim HO, Lee W, Kook YA, Kim Y. Comparison of the condyle-fossa relationship between skeletal class III malocclusion patients with and without asymmetry: a retrospective three-dimensional cone-beam computed tomograpy study. Korean J Orthod2013; 43(5):209-217.
10. Barghan S, Tetradis S, Mallya S. Application of cone beam computed tomography for assessment of the temporomandibular joints. Aust Dent J 2012; 57(Suppl 1):109-18.
11. Hintze H, Wiese M,Wenzel A. Cone beam CT and conventional tomography for the detection of morphological temporomandibular joint changes Cone beam CT and conventional tomography for the detection of morphological temporomandibular joint changes.DentomaxillofacRadiol 2007; 36(4):192-7
12. Krisjane Z, Urtain I, Krumania G, Neimane L, Ragovska I. The prevalence of TMJ osteoarthritis in asymptomatic patients with dentofacial deformities: a cone beam CT study. Inter J Oral and MaxillofacSurg 2012;41(6):690-5.
13. Tecco S, Saccucci M, Nucera R, Polimeni A,Pagnoni M, Cordasco G, et al. Condylar volume and surface in Caucasian young adult subjects. BMC Med Imaging 2010;31:10-28.
14. Librizzi ZT, Tadinada AS, Valiyaparambil JV, Lurie AG, Mallya SM. Cone-beam computed tomography to detect erosions of the temporomandibular joint: Effect of fi eld of view and voxel size on diagnostic efficacy and effective dose. Am J Orthod Dentofac Orthop 2011;140:e25-30.
15. 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. DentomaxillofacRadiol2010;39:270-6.
16. Farronato G, Garagiola U, Carletti V, Cressoni P, Mercatali L, Farronato D. Change in condylar and mandibula morphology in juvenile idiopathic arthritis: Cone Beam volumetric imaging. Minerva Stomatol 2010;59:519-34.
17. Hansson T, Oberg T, Carlsson GE, Kopp S. Thickness of the soft tissue layers and the articular disk in the temporomandibular joint. ActaOdontolScand 1977; 35:77-83.
18. Wiese M, Wenzel A, Hintze H, Petersson A, Knutsson K, Bakke M, et al. Osseous changes and condylar position in TMJ tomograms: Impact of RDC/TMD clinical diagnosis on agreement between expected and actual fi nding. Oral Surg Oral Med Oral Pathol Oral RadiolEndod2008;106:52-63.
19. Sicher H, DubRule EL. Sicher’s oral anatomy. 5th ed. St. Louis: C.V. Mosby; 1980. p.158.
20. Gateno J, Anderson PB, Xia JJ, Horg JC, Teichgraeber JF, Liebschner MA. A comparative assessment of mandibular condylar position in patients with anterior disc displacement of the temporomandibular joint. J Oral MaxillofacSurg2004;62:39-43.
21. Katzberg RW, Keith DA, Ten Eick WR, et al: Internal derangements of the temporomandibular joint: An assessment of condylar position in centric occlusion. J Prosthet Dent 1983;49:250.
22. Kinniburgh RD, Major PW, Nebbe B, West K, Glover KE. Osseous morphology and spatial relationships of the temporomandibular joint: Comparisons of normal and anterior disc positions. Angle Orthod 2000; 70:70-80.