Multiplanner Measurement to the Clicked Tempromandibular Joint (Condylar Process and Articular Dick) with Conbeam Computed Tomography

Nameer Fadhel[1], Manar Abd Alrazaq Hassan[2], Nour Abd Alrazaq Hassan[2]

[1] Department of Human Anatomy, College of Medicine, Dyiala University, Iraq,
[2]Department of Physics, College of Science, Dyiala University, Iraq

Abstract

Background: The purpose of the current study was to actualization, the relationship of condyle-fossa position, in clinically symptomatic untreated in first dental special center in baquba, and by cone-beam computed tomography (CBCT). Objectives: Cone-beam computed tomography was superior to conventional radiography and conventional tomography for estimating internal disorders of temporomandibular joint. Cone-beam computed tomography demonstrated excellent evaluation of bony structures. Methods: fifty patients were examined in this study. Temporomandibular Joint with cone-beam computed tomography of the patients. Width and shape of glenoid fossa, width and shape of condyle, symptoms of the patient, soft tissue and clicking in both the right and left TMJs were measured. Data were analyzed using ANOVA test. Results: A statistically significant differences in the position right and left condyles were found among the patients that complete edentulous, partial edentulous, and fully erupted teeth. In patients, significant statistical differences were found between right and left TMJs in both values the X axis and the Y axis values. The difference between the right and the left X axis values in patients was also statistically significant. Conclusion: Cone-beam computed tomography is most commonly used in oral and maxillofacial surgery, implant dentistry and orthodontics. Cone-beam computed tomography examination not accepted unless its medical necessity is established and the benefits superimposes the risks.

Key Words: *mandibular condyle, glenoid fossa, Temporomandibular joint*

Introduction

Pain related to the temporomandibular joint (TMJ) was mutual in the most population. Only about 3%-7% of the patients with pain linked to TMJ disorder and seek to the medical care [1,2]. Although TMJ disorders or dysfunctions were the most popular clinical conditions that refer to the imaging examination, pathologies that specific to the bone and the joints also common. Cone-beam computed tomography was the most widely technique of choice that used for diagnostic. Cone-beam computed tomography (CBCT) is a new medical imaging technique that creates 3-D images at a lower absorbed dose and cost comparing with conventional computed tomography (CT). This imaging technique based on a X-ray beam with cone-shaped that concentrated on a 2-D detector that achieves by one rotation around the object, and produced a series of 2-D images [3]. These images are re-constructed in 3-D using a modification developed by Feldkamp *et al.* in 1984 that modified original cone-beam algorithm. Craniofacial region images were often collected with a advanced resolution than those collected with a conventional CT. In addition, the new systems were more practical, due to come in smaller sizes [2]. Considerably TMJ underdeveloped at birth in comparison to other diarthrodial joints making it more exhibit to perinatal and postnatal abuses. TMJ has an articular surfaces, disk, synovial fluid, fibrous capsule, synovial membrane, and ligaments. TMJ are comprises from mandibular condyle inferiorly and the glenoid fossa superiorly and articular eminence of the temporal bone[3].

The mandibular condyle appearance was awfully variable between patients and in different age groups. The cranial component of the TMJ lies beneath the

squamous portion of the temporal bone anterior to tympanic plate [4]. The articular fossa was formed entirely by the squamous portion of the temporal bone. Along the medial aspect of the glenoid fossa was the petrotympanic fissure anteriorly and the petrosquamous fissure posteriorly. The articular eminence (AE) forms the anterior boundary of the glenoid fossa [5]. The AE is a transverse bony bar anterior to the glenoid fossa and medial to the posterior margin of the zygomatic process. The articular disk was biconcave, round or oval, avascular fibrocartilage located between the condyle and glenoid fossa. The disk was significantly thinner centrally in the intermediate zone [6]. Instead, the disk is firmly attached to the medial and lateral poles of the mandibular condyle. This allows simultaneous movements of the disk and the condyle. The muscles of mastication (medial and lateral pterygoids, masseter, and temporalis) in addition to other accessory muscles help opening and closing of the jaw [4,6].

Biomechanics of TMJ movements

Jaw movement comprises the high level of coordination and interaction between bilateral mandibular condyles, muscles, disk, and ligaments of the joints [7]. The functional interactions within the TMJ are complex and incompletely understood [8, 9]. A basic view of the complex interactions in open and closed mouth positions was describe, in a normal joint, the thin intermediate zone of the disk always interrupted between the condyle and the temporal bone in both the closed-mouth and open-mouth situations, for prevention articular damage. In the closed position of the mouth, the condyle fixed in the glenoid fossa. The disk was interposed between the glenoid fossa superiorly and the condyle inferiorly. The articular eminence located anterior to the articular disk. The normal disk positioned in front of the condyle and the junction of the posterior band and bilaminar zone located immediately superior to the condylar head near the 12 o'clock position [1, 3,4,9,10-11]. However, some controversy exists over the range of normal position of the disk [1, 3, 4, 11-12]. The junction of the posterior band and bilaminar zone should located within 10 degree of vertical to be within 95 percentile of normal. There was significant relationship variation of the posterior band and bilaminar zone in normal people, resulting in incongruous classification the displacement of the anterior disk [13, 14]. Rammelsberg et al [15] proposed the disk positions of up to +30° from the vertical be considered normal. Many other authors have suggested that the intermediate zone be the point of reference so that in a normal joint it was interposed between the condyle and the temporal bone in all joint positions [16, 17]. Comparing to the different disk positions of 12, 11 and 10 o'clock, and establish the intermediate zone criterion for disk displacement to be more stringent. Recently [17] have proposed parallel conclusions the inferior belly alternately contracts, this produces lateral movement of the jaw.

Imaging techniques

CMCT is suitable to assess the bony elements of the TMJ. CT is perfect to evaluation the fractures, erosions, infection, degenerative changes, invasion by tumor, as well as most bony congenital anomalies [18]. A typical imaging protocol is: 120 kV, 100 mA, 1 mm collimation, 1 mm/rotation (pitch), and imaged with a closed mouth[18]. CT is principally done when the suspicion of bony involvement from the MRI and if primary bony pathologies were suspected clinically. Cognate advantages of CBCT over MRI include, fascinating bone details and 3D evaluation of congenital, traumatic, pathological and postsurgical conditions.

Materials and Method

A hundred patient were identified by gender, age, were used in this study. To undertake the measurements 10 linear distances were selected in the maxilla and mandible. The selected lines were orientated vertically, horizontally, and obliquely to account for linear measurements made in all three dimensions [8]. The gold standard was obtained for each of the 10 lines by physical measurements using a digital caliper with an accuracy of 0.01 mm (Gamma, Amsterdam, and the Netherlands). The physical measurements were repeated twice by three independent observers. The normal disc position of the 100 subjects was confirmed by history, clinical examination and cone-beam computed tomography (CBCT) [9]. Then, the images of the TMJ of the subjects were taken using CBCT to evaluate the optimal Shape of the condylar and fossa.

Statistical Analysis

The gold standard accuracy of the selected distances was established by averaging the physical measurements

of the three observers (double blind examination). The mean of each measurement for each image type was compared with the mean of the gold standard using analysis of variance of repeated measurements. The significance level was set to $P \leq 0.05$. Corresponding image types were measured for all scan positions to minimized interaction with the statistical results. ANOVA test were used for each measurement to evaluate the average differences between the right and left side for each element of the sample [6].

Results

The measurements were processed and analyzed using SPSS 20.0. For all values of the variables, the mean and standard deviation were reckon, based on patient's gender, ratios of male to female, shape of condyles (Table 1, 2, 3,4 and 5). The distribution of quantitative variables (condylar shape, condylar fossa) was measured for normality using the Shapiro-Wilk test before analysis. The ANOVA test was used where appropriate to examine the difference in mean between gender (male and female). P-values was determine the difference between the right and left sides of the mandible.

Statistical data for the result:

The results in table (1) show the percentage of males to female.

Table (1) ratios of male to female

Male	Female
68%	32%

However, revealed a significant difference between genders when shape of condyles and gleniod fossa were compared.

The ratios of the shape of condyles in left side of the males was showed high percentage of rounded shape of condyles in left side compared to other shapes as a 16% flat, 8% oval and 4% irregular shape. Nevertheless in the females the shape of the left condyle was estimate 12% oval shape, 10% rounded, 8% flat and 2% irregular shape.

The shape ratios of the condyles in right side of males was: irregular 0%, flat 20%, oval 4% and high [percentage of rounded 44% and in left side of the females: irregular 0%, flat 14%, oval 8% and rounded 10%, respectively as show in table (2).

Table (2) show shape of condyles

	Male				Female			
	Irregular	**Flat**	**Oval**	**Rounded**	**irregular**	**Flat**	**Oval**	**rounded**
Left	4%	16%	8%	40%	2%	8%	12%	10%
Right	0	20%	4%	44%	0	14%	8%	10%

The ratios of the shape of glenoid fossa condyles in left side was in males irregular 4%, flat 26%, oval 6% and rounded 36% and in left side of the females irregular 0%, flat 8%, oval 6% and rounded 14%, respectively.

The ratios of the shape of condyles in right side was in males: irregular 6%, flat 20%, oval 20% and rounded 28% and in left side of the females: irregular 0%, flat 8%, oval 8% and rounded 10%, respectively as show in table (3).

Table (3) show shape of gleniod fossa

	Male				**Female**			
	Irregular	**Flat**	**Oval**	**Rounded**	**Irregular**	**Flat**	**Oval**	**rounded**
Left	4%	26%	6%	36%	0	8%	6%	14%
Right	6%	20%	20%	28%	0	8%	8%	10%

There was significant difference between males and females when condylar shape and glenoid fossa was compared. In addition, the mean values of condylar shape in males were higher compared to females (Table 4).

Table (4) statistical analysis of condylar shape.

Variable	**number**	**Mean**	**SE**	**Maximum**	**Minimum**	**P Value**
Left	100	18.9	± 4.2165	23.1	14.9	0.04
Right	100	17.85	± 5.2765	24.5	14.4	0.03

The glenoid fossa shape of the left and right side of the mandible were showed, and the values were predisposes to statistical analysis include (mean, stander error, maximum, minimum and *P* Value) as show in (Table 5). P-values were used for each measurement to evaluate the average differences between the right and left side for each element of the sample.

The results showed significant difference among males and females in left side glenoid fossa but showed non-significant differance among males and females in right side glenoid fossa diminsion.

Table (5) statistical analysis of glenoid fossa shape.

Variable	**number**	**Mean**	**SE**	**Maximum**	**Minimum**	**P Value**
Left	100	22.5	± 5.7389	28.5	17.5	0.01
Right	100	22.1	± 4.9870	27	16.9	0.06

Figure (1): CBCT picture of a normal TMJ

Discussion

Academy of Dento-Maxillo-Facial Radiology has developed the basic principles of CBCT uses of in dentistry [13]. CBCT examinations must not be carried out unless a necessary use have been performed and must be justified for each patient to reveal that the benefits outrun the risks. CBCT offer a choice of volume, sizes, and examinations must use the smallest and compatible with the clinical situation, if this offers a lower radiation dose to the patient [12] and the resolution compatible with an adequate diagnosis and the lowest achievable dose should be used.

The results showed highest percentage in patient that severing from clicking symptom in rounded shape condylar process and glenoid fossa in both left and right side and in both gender (males and females), comparing with other shapes of the two variables agree with [19]. These population that sever from clicking symptom with irregular shape showed lower ratio when comparing with other shape, but also showed uneven percentage between both flat and oval shape of condyle and glenoid fossa.

When comparing of two structure of TMJ showed, in males showed rounded shape left condyle represented about 40% and 36% rounded shape left glenoid fossa, this disproportion in the percentage of the shape of two structure cause difficulty in joint movement during opening and closing of the mouth agree with[20] round shape condyle represented higher percentage . While in irregular shape left condyle and glenoid fossa represented about 4% of patients that severing from clicking, this low percentage of patient that showed clicking during joint movement due to disharmony in the shape of two anatomical structure. Nevertheless oval shape of left condyle represented about 8% while the glenoid fossa represented about 6%. While the flat shape left condyle constitutes 16% while the left glenoid fossa that has flat shape constituted 26%. When examined the right side of all males showed the highest percentage represented by round shape of both anatomical structure. Round right condyle represented about 44%, while its glenoid fossa represented by 28% all patient. Nevertheless the second percentage of the patients that have flat shape condyle and glenoid fossa, that represented by 20%. While the other shape "oval and irregular showed different percentage "condyle 4%-0% and joint fossa 20%-6%) all these different percentage in different shapes of anatomical structure causes painful symptom like concurrent with joint clicking. In females also showed different shape of

condylar process and glenoid fossa when examined by CBCT and also the high percentage of the patient that have clicking in round shape joint structure agree with [20].

Conclusion

CBCT is most frequently applied in oral and maxillofacial surgery, CBCT examination must not be carried out unless its medical necessity is proven. Large percentage of population had clicking with round shape condylar and glenoid fossa, and lower percentage had irregular shape TMJ unit Difference in the shape of TMJ units increase the risk of the clicking.

Conflict of Interest: None

Funding: Self

Ethical Clearance: Not required

References

1- Aiken A, Bouloux G, Hudgins P. MR imaging of the temporomandibular joint. Magn Reson Imaging Clin N Am. 2012; 20:397–412.

2- Guralnick W, Kaban LB, Merrill RG. Temporomandibular-joint afflictions. N Engl J Med. 1978; 299:123–129.

3- Alomar X, Medrano J, Cabratosa J, Clavero JA, Lorente M, Serra I, Monill JM, Salvador A. Anatomy of the temporomandibular joint. Semin Ultrasound CT MR. 2007; 28:170–183.

4- Sommer OJ, Aigner F, Rudisch A, Gruber H, Fritsch H, Millesi W, Stiskal M. Cross-sectional and functional imaging of the temporo-mandibular joint: radiology, pathology, and basic biomechanics of the jaw. Radiographics. 2003; 23:e14.

5- Sava A, Scutariu M. Functional anatomy of the temporo-mandibular joint (II) Rev Med Chir Soc Med Nat Iasi. 2012; 116:1213–1217.

6- Eijden TM, Korfage JA, Brugman P. Architecture of the human jaw-closing and jaw-opening muscles. Anat Rec. 1997; 248:464–474.

7- Imanimoghaddam M, Madani AS, Hashemi EM. The evaluation of lateral pterygoid muscle pathologic changes and insertion patterns in temporomandibular joints with or without disc displacement using magnetic resonance imaging. Int J Oral Maxillofac Surg. 2013;42:1116–1120

8- Tomas X, Pomes J, Berenguer J, Quinto L, Nicolau C, Mercader JM, Castro V. MR imaging of temporomandibular joint dysfunction: a pictorial review. Radiographics. 2006; 26:765–781.

9- Koolstra JH. Dynamics of the human masticatory system. Crit Rev Oral Biol Med. 2002; 13:366–376.

10- Katzberg RW, Westesson PL, Tallents RH, Drake CM. Anatomic disorders of the temporomandibular joint disc in asymptomatic subjects. J Oral Maxillofac Surg. 1996; 54:147–153; discussion 153-155.

11- Barghan S, Tetradis S, Mallya S. Application of cone beam computed tomography for assessment of the temporomandibular joints. Aust Dent J 2012; 57: 109–18.

12- Patel A, Tee BC, Fields H, Jones E, Chaudhry J, Sun Z. Evaluation of cone-beam computed tomography in the diagnosis of simulated small osseous defects in the mandibular condyle. Am J Orthod Dentofacial Orthop 2014; 145: 143–56.

13- Zhang ZL, Cheng JG, Li G, Zhang JZ, Zhang ZY, Ma XC. Measurement accuracy of temporomandibular joint space in Promax 3-dimensional cone-beam computerized tomography images. Oral Surg Oral Med Oral Pathol Oral Radiol 2012; 114: 112–17.

14- Quereshy FA, Savell TA, Palomo JM. Applications of cone beam computed tomography in the practice of oral and maxillofacial surgery. J Oral Maxillofac Surg. 2008 Apr; 66(4):791-6.

15- Rammelsberg P, Pospiech PR, Jäger L, Pho Duc JM, Böhm AO, Gernet W. Variability of disk position in asymptomatic volunteers and patients with internal derangements of the TMJ. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1997; 83:393–399.

16- Zhang ZL, Shi XQ, Ma XC, Li G. Detection accuracy of condylar defects in cone beam CT images scanned with different resolutions and units. Dentomaxillofac Radiol 2014; 43: 20130414.

17- Felson DT. Osteoarthritis: priorities for osteoarthritis research: much to be done. Nat Rev Rheumatol 2014; 10: 447–8.

18- Larheim TA. Diagnostic imaging of the TMJ. In: Oral and maxillofacial surgery knowledge update 2014, volume V(OMSKU V) (Busaidy KF, ed.).

19- Natheer Hashim Al-Rawi, Asmaa Tahseen Uthman, and Sahar M. Sodeify. Spatial analysis of mandibular condyles in patients with

temporomandibular disorders and normal controls using cone beam computed tomography, Volume 11(1); Jan-Mar 2017.

20- Madhumati Amritraj Singh, Anatomical Variations in Condylar Shape and Symmetry: Study of 100 Patients. Volume 4 Issue 12, December 2015.