ОРИГИНАЛЬНАЯ СТАТЬЯ

EVALUATION OF MANDIBULAR CONDYLAR MEASUREMENTS USING CONE-BEAM COMPUTED TOMOGRAPHY

Farah A. Hadi[1], Zainab M. Al-Bahrani[1], Areej Ahmed Najm[1], Wassan Jamal Obaid[2]

1 – College of Dentistry, University of Baghdad, Department of Oral Diagnostic Sciences.
2 – Amria Specialized Center. Baghdad, Iraq.

Purpose. A study was performed to determine the mandibular condyle measurements through proper imaging of cone-beam computed tomography (CBCT).

Material and methods. CBCT was used to assess 100 images of mandibular condylar for 50 subjects with age range from 18-44 years, the linear measurements of the condyle size (length, width and height) were identified by specific anatomical landmarks and analyzed statistically.

Results. This study shows a high-significant difference according to gender for the three linear measurements (length, width and height), males were higher than females. With regards to comparison of both condyles, the means of condylar volume, width and height of the right side were significantly higher, no significant difference for all measurements were detected between the three age groups.

Conclusion. Cone beam computed tomography measurements of mandibular condylar vary according to side, age, and gender. These measurements are valuable important to performed a treatment plan and improvement of health for the patients.

Discussion. Many studies have been evaluated mandibular condyles measurements to investigate any correlation with gender, side, and age groups. The variations that were found in this study when compared to other studies were due to the fact that the samples collected were significantly different in size, in gender distribution, the CBCT machine used, ethnic differences and environment.

Keywords: mandibular condyle measurements, cone-beam computed tomography, improvement of health.

Corresponding author: Farah A. Hadi, e-mail: farah.hadi@codental.uobaghdad.edu.iq

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ОЦЕНКА ИЗМЕРЕНИЙ МЫЩЕЛКОВОГО ОТРОСТКА НИЖНЕЙ ЧЕЛЮСТИ С ИСПОЛЬЗОВАНИЕМ КОНУСНО-ЛУЧЕВОЙ КОМПЬЮТЕРНОЙ ТОМОГРАФИИ

Фарах А. Хади[1], Зейнаб М. Аль-Бахрани[1], Аридж Ахмед Наджм[1], Вассан Джамал Обаид[2]

1 – Стоматологический колледж, Багдадский университет, кафедра диагностики заболеваний ротовой полости. Багдад, Ирак.
2 – Специализированный центр Амрия. Багдад, Ирак.

Цель исследования. Определить параметры мыщелкового отростка нижней челюсти с использованием конусно-лучевой компьютерной томографии (КЛКТ).

Материалы и методы. С помощью КЛКТ были оценены 100 изображений мыщелковых отростков нижней челюсти у 50 пациентов в возрасте от 18 до 44 лет. Линейные

измерения размеров отростка (длина, ширина и высота) были определены по специфическим анатомическим ориентирам и проанализированы статистически.

Результаты. Исследование выявило значительные различия по полу для всех трех линейных измерений (длина, ширина и высота): у мужчин значения были выше, чем у женщин. При сравнении параметров обоих отростков средние значения объема, ширины и высоты правого отростка были значительно выше. Не было обнаружено значительных различий в измерениях между тремя возрастными группами.

Заключение. Измерения мыщелковых отростков нижней челюсти с использованием конусно-лучевой компьютерной томографии варьируются в зависимости от стороны, возраста и пола. Эти измерения имеют важное значение для составления плана лечения и улучшения здоровья пациентов.

Обсуждение. Многие исследования были посвящены оценке параметров мыщелковых отростков нижней челюсти для выявления корреляции с полом, стороной и возрастными группами. Различия, обнаруженные в данном исследовании по сравнению с другими, обусловлены тем, что собранные образцы значительно различались по размеру, распределению по полу, используемому оборудованию КЛКТ, этническим различиям и окружающей среде.

Ключевые слова: измерения мыщелковых отростков нижней челюсти, конусно-лучевая компьютерная томография, улучшение здоровья.

Контактный автор: Фарах А. Хади, e-mail: farah.hadi@codental.uobaghdad.edu.iq

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The temporomandibular joint (TMJ) is one of the most distinctive and complex synovial joints in the body. It is the area in which the mandible articulates with the cranium, located between the squamous region of the temporal bone of the skull above and condylar process of the mandible below, so the condyle considered as the bony components of the TMJ's that connects it to the skull base [1-4].

The clinical significance of condyle-fossa relationships in the temporo-mandibular joint is a matter of controversy [5]. As the primary center of growth in the mandible, the condyle responds to continuous stimuli throughout the remodeling process, and thus plays an important role in the final dimensions of the adult mandible. It's volume and size can be related to the final dimensions of the mandible as well as to the final relationship between maxillary and mandibular arches [6]. The mandibular condylar varies significantly between individuals and is associated with age, sex, facial type, functional load, and right and left sides the variation in the shape and size of the condyle among different studies is multifactorial [7-8].

Radiographic examination forms an integral component of the clinical assessment routine in patients with temporomandibular joint dysfunction that clinically characterized by reciprocal clicking due to shifting the disc anteriorly in relation to the condyle and fossa during mandible elevation [9, 10]. Due to the complex anatomy of the TMJ and the continual stress it undergoes, it is prone to both local and systemic pathologies [11]. The temporomandibular joint component can be viewed by various imaging techniques, several studies have reported high accuracy when using cone-beam computed tomography (CBCT), it is relatively a new imaging modality that used commonly in dental practice, provides precise imaging without superimposition and distortion [12, 13, 14]. Oral radiologists consider it to be an effective tool providing two and three- dimensional images with obvious details, cheaper cost, and with a relatively low dose and cost [15].

Proper imaging of condylar dimensions allows practitioners to evaluate an asymptomatic TMJ for potential degenerative changes prior to surgical and orthodontic treatment [16]. The present study is performed to determine the measurements of the mandibular condylar process (length, width, and height) with their correlation to age, gender, side of the jaw to recognize variations using cone beam computed tomography.

Material and methods.

The sample included CBCT images of 100 mandibular condylar of 50 Iraqi subjects who attending the oral and maxillofacial radiology unit at college of dentistry, University of Baghdad for different diagnostic purposes, using Dentium CBCT imaging device with standard scanning mode parameters at 90 kV, 8 mA, and 20seconds scan time, the age range is from 18 to 45 years, they were subdivided into 3 groups according to age (G1= 18-26y, G2=27-35y, and G3= 36-44y), any images which have obvious Condylar process without any pathological defect or anatomical abnormalities are included, while those that showed any pathology, fractures or trauma to the mandible that affected the condyle or its position, hemifacial atrophy, poor image quality that cause difficulty in examining the target area and loss of patient maximum intercuspation are excluded from this study. The study is designed to analyze the linear measurements of the condyle size (length, width and height). A two-dimensional sagittal slice is selected to examine the condyle clearly; the condylar length is measured from the line extending from a point at the posterior mandibular condyle to the point at anterior mandibular condyle that located inferior to the superior mandible condyle about 4 mm on either side of the condyle. Condylar width defined as the linear distance between the medial and lateral mandible poles in the coronal plane, Condylar height was represented by measuring the perpendicular linear distance from superior mandible condyle to a line constructed between the most inferior point of the sigmoid notch perpendicular to the tangent of the posterior surface of the ramus in the sagittal plane (fig. 1).

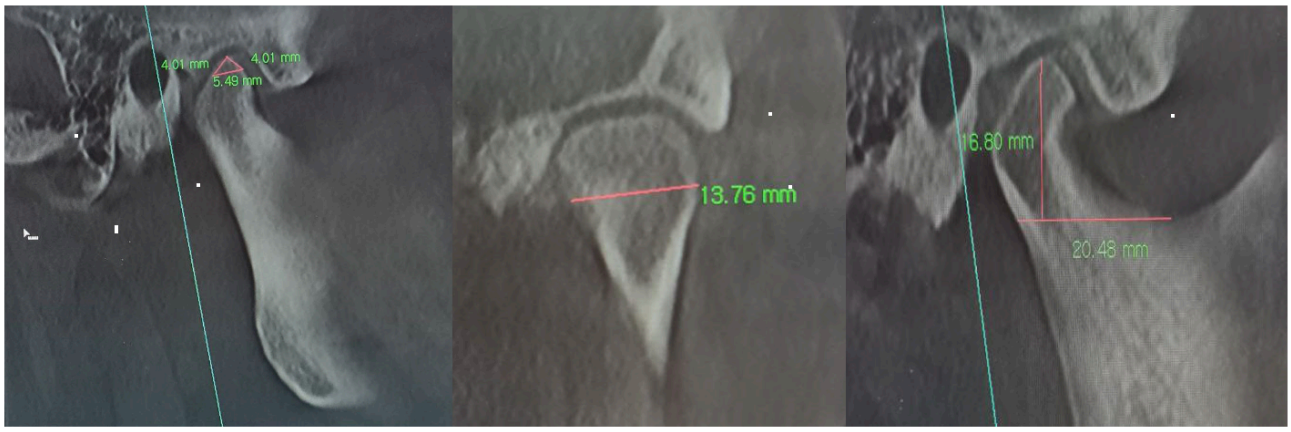

Fig. 1 (Рис. 1)

Fig. 1. CBCT, mandibular condyle.

A – sagittal view, condylar length measurement. It is about 5.49 mm representing distance line extending from a point at the posterior mandibular condyle to the point at anterior mandibular condyle that located inferior to the superior mandible condyle about 4.01 mm on either side of the condyle.

B – coronal view, condylar width measurement. It is about 13.76 mm representing the linear distance between the medial and lateral mandible poles in the coronal plane.

C – sagittal view, condylar height measurement. It is about 16.80 mm representing perpendicular linear distance from superior mandible condyle to a line constructed between the most inferior point of the sigmoid notch perpendicular to the tangent of the posterior surface of the ramus in the sagittal plane.

Рис. 1. КЛКТ, мыщелковый отросток нижней челюсти.

А – сагиттальная плоскость, измерение длины мыщелкового отростка. Длина отростка составляет примерно 5,49 мм и представляет собой расстояние между точкой на заднем полюсе отростка и точкой на переднем полюсе отростка, расположенной ниже верхней точки отростка на 4,01 мм с обеих сторон.

В – коронарная плоскость, измерение ширины мыщелкового отростка. Ширина отростка составляет примерно 13,76 мм и представляет собой линейное расстояние между медиальным и латеральным полюсами отростка в коронарной плоскости.

С – сагиттальная плоскость, измерение высоты мыщелкового отростка. Высота отростка составляет примерно 16,80 мм и представляет собой перпендикулярное линейное расстояние от верхней точки отростка до линии, проведенной между самой нижней точкой сигмовидной вырезки и задней поверхностью ветви нижней челюсти в сагиттальной плоскости.

The statistical analysis was done by using Microsoft excel version 2010 and GraphPad Instant program. A descriptive analysis was performed for condylar height, length and width in relation to gender, side and age group. Differences between gender for length, width and height of condyle measurements were checked using Unpaired t-test (independent t-test). Differences between right and left sides was tested statistically for significance difference by using paired t-test, while the differences between the age groups was checked by one way ANOVA test.

Results.

Fifty CBCT images of patients were retrieved from the archive (25 males and 25 females) with age ranged 18-44 y. The mean and standard deviation of condylar length, width and height were measured in males and females. A high-significant difference was found between male and female regarding three linear measurements (P-value< 0.0001). The length, width and height were higher in male (7.10±0.22 mm, 15.21±0.87 mm, 19.34±0.76 mm respectively) as shown in table №1.

Table №1. Comparison of condylar length, width and height (in mm) in relation to gender.

variables		Male	Female	P-value
No.		25	25	
Length	Mean	7.10	5.67	P<0.0001 HS*
	SD	0.22	0.78	
	Low. 95% conf. limit.	7.01	5.35	
	Up. 95% conf. limit.	7.19	5.99	
	Range	6.45 - 7.39	4.39 – 7.29	
Width	Mean	15.21	13.52	P<0.0001 HS*
	SD	0.87	1.24	
	Low. 95% conf. limit.	14.85	13.01	
	Up. 95% conf. limit.	15.57	14.03	
	Range	13.40 – 16.91	11.28 – 16.19	
Height	Mean	19.34	16.66	P<0.0001 HS*
	SD	0.76	1.26	
	Low. 95% conf. limit.	19.02	16.14	
	Up. 95% conf. limit.	19.66	17.18	
	Range	17.83 – 20.65	14.32 – 20.01	

*HS means high significant difference (by independent t-test)

The mean and standard deviation of condylar length, width and height were measured in both right and left side. A non-significant difference was found between right and left side regarding the length (6.43±1.02 mm, and 6.35±1.02 mm) respectively. The width and height were higher in right side and the differences were statistically significant (p<0.05) as shown in table №2.

Regarding the changes in condylar measurements with age, the total sample was divided into 3 groups according to age (G1= 18-26y., G2=27-35y., and G3= 36-44y.). By using ANOVA test, the statistical difference was measured and no significant differences were detected between the three groups regarding the three variables. As shown in details in table №3.

Discussion.

Mandibular condyles are described as one of the most important parts of the temporomandibular complex, so that condyle morphology often provides a better understanding of certain disorders, and is crucial for accurate diagnosis to recognize any variations or abnormalities in these structures, especially when performing orthodontic management and orthognathic surgery [17].

Many studies have evaluated mandibular condyles measurements to investigate any correlation with gender, side, and age groups.

The mandibular condyle appearance and morphology may vary to a great extent from one individual to another and between different age groups [9, 18].

Regarding to the gender this study shows a high-significant difference between male and female for the three linear measurements (length, width and height), males were higher than females, table 1 this probably may due to the difference in general size of the condyle between males and females, Al-koshab et al also reported that overall size of the condyle in males was

Table №2. Comparison of condylar length, width and height (in mm) in relation to condylar side.

variables		Right side	Left side	P-value
No.		50	50	
Length	Mean	6.43	6.35	P = 0.53 NS*
	SD	1.02	1.02	
	Low. 95% conf. limit.	6.14	6.06	
	Up. 95% conf. limit.	6.72	6.64	
	Range	4 – 7.69	4.02 – 7.66	
Width	Mean	14.67	14.06	P = 0.013 S**
	SD	1.60	1.60	
	Low. 95% conf. limit.	14.22	13.60	
	Up. 95% conf. limit.	15.13	14.51	
	Range	11.34 – 18.32	11 – 17.46	
Height	Mean	18.21	17.79	P = 0.04 S**
	SD	1.92	1.75	
	Low. 95% conf. limit.	17.66	17.29	
	Up. 95% conf. limit.	18.76	18.29	
	Range	14.76 – 22.88	13.88 – 21.47	

*NS means non-significant difference (by paired t-test)

**S means significant difference (by paired t-test)

Table №3. Comparison of condylar length, width and height (in mm) in relation to age groups.

variables		18-26	27-35	36-44	P-value
No.		20	18	12	
Length	Mean	6.59	6.45	5.96	P = 0.16 NS*
	SD	0.69	0.92	1.14	
	Low. 95% conf. limit.	6.26	5.99	5.23	
	Up. 95% conf. limit.	6.91	6.91	6.68	
	Range	5.42-7.39	4.59-7.38	4.39-7.16	
Width	Mean	14.73	14.49	13.58	P = 0.56 NS*
	SD	1.12	1.34	1.53	
	Low. 95% conf. limit.	14.21	13.82	12.60	
	Up. 95% conf. limit.	15.26	15.15	14.55	
	Range	12.44-16.91	11.99-16.85	11.28-15.28	
Height	Mean	18.42	17.97	17.34	P = 0.22 NS*
	SD	1.42	1.73	1.98	
	Low. 95% conf. limit.	17.76	17.11	16.08	
	Up. 95% conf. limit.	19.09	18.84	18.61	
	Range	16.39-20.58	15.29-20.24	14.32-20.65	

*NS means non-significant difference (by ANOVA test)

significantly larger than in females, and this was also confirmed by a study conducted by Coogan et al which found that male condyles were on average larger than female condyles [19, 20]. Condylar volume was assessed by Ceratti et al and Lo Giudice et al, with statistically significant differences according to gender and this result come in confirm with our study results comparing the width and height in males are larger than in females [21, 22].

In this study, there was a significant difference between sides when comparing the condylar width and height, right side was higher and the differences were statistically significant ($p<0.05$) as shown in table 2. This asymmetry could be related to normal cranial base asymmetries in addition to the present of different types of malocclusions with a preferred side for mastication in subjects with malocclusion. Wang and Rodrigues et al discussed the relationship between sides (right and left) in addition to joint spaces, they found that there was no significant difference between left and right sides [16, 23]. Cohlmia et al suggested that condyle is asymmetric in a normal population [24].

No significant differences were detected in this study regarding the condylar measurements according to age groups, older subjects were excluded because they may have had the progressive degenerative bone changes that cause TMJ osteoarthritis, this was in agreement with a study performed by Liu et al that showed no statistical differences were found in volume and surface among different age groups [25]. Yun et al study shows a significant increase in mediolateral and anteroposterior width of the left and right condyles in male and female with age [26].

As a conclusion variety of TMJ joint diseases and abnormality can be estimated from the condyle size, generally, the condyle measurements exhibited a larger value in males than females, while the evaluation of side symmetry shows asymmetrical findings, so each condyle must be evaluated independently. The results of such a study are helpful to customize a treatment planning for each patient preoperatively for improvement of health. CBCT cross-sectional imaging can present an accurate and valuable information that serve this purpose.

References:

1. Kaprin A.D., Starinsky V.V., Shakhzadova A.O., 1. Tamimi, D., Jalali, E. & Hatcher, D. Temporomandibular joint imaging. Radiol. Clin. N. Am. 56, 157–175 (2018).

2. Okeson J P, Management of Temporomandibular Disorders and Occlusion-E-Book, Elsevier Health Sciences, Amsterdam, Netherlands, 2019.

3. Othman, Ahmed Adel; Aswad, Fawaz. Clinical evaluation of the pain predictors among temporomandibular joint disorders patients with full dentition and free-end extensions: An Analytical Cross-Sectional Study. Dental Hypotheses 14(1): p 7-9, Jan–Mar 2023.

4. Alqhtan NR et al. Temporomandibular Joint Space Dimensions among Saudi Patients with Temporomandibular Disorders: MRI-Based Retrospective Study. International Journal of Clinical Practice, Volume 2022, Article ID 5846255, 9 pages.

5. Ikeda K, Kawamura A. Assessment of optimal condylar position with limited cone-beam computed tomography. Am J Orthod Dentofacial Orthop.2009; 135: 495–501.

6. 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 Mar;38(3):141-7.

7. Hegde S, Praveen BN, Shetty SR. Morphological and radiological variations of mandibular condyles in health and diseases: a systematic review. Dentistry. 2013; 3:154

8. Al-Ghurabi ZH, Al-Bahrani ZM. Cone Beam Computed Tomography Evaluation of the Morphological Variation and Width in Mandibular Condyle. The Journal of Craniofacial Surgery. Volume 32, Number 5, July/August 2021

9. Krishnamoorthy B, Mamatha N, Kumar VA. TMJ imaging by CBCT: Current scenario. Ann Maxillofac Surg. 2013 Jan;3(1):80-3.

10. Alhussien FT, Ryhan A. Effectiveness of Intra articular Injection of Platelet-Rich Plasma in Patients with Anterior Disc Displacement with Reduction. J Bagh Coll Dent. 2017; 29: 44-52.

11. Kim SSY and Somers M. Total temporomandibular joint replacement without a submandibular incision. J Oral Med Oral Surg 2020; 26:43

12. Ejima K, Schulze D, Stippig A, Matsumoto K, Rottke D, Honda K. Relationship between the thickness of the roof of glenoid fossa, condyle morphology and remaining teeth in asymptomatic European patients based on cone beam CT data sets. Dentomaxillofac Radiol. 2013;42(3):90929410.

13. Kijima N, Honda K, Kuroki Y, Sakabe J, Ejima K, Nakajima I. Relationship between patient characteristics, mandibular head morphology and thickness of the roof of the glenoid fossa in symptomatic temporomandibular joints. Dentomaxillofacial Radiology. 2014; 36: 249–255.

14. 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 research journal. 2012; 9: 607

15. Al Bayati RM, Saliem SS, Al Nakib LH. Relation of Gonial Angle Index to osteoporosis and age using CBCT in female subjects. J Bagh Coll Dentistry 2018; 30(2):41-46

16. Wang R, Ma X, Zhang W, Liu D. Investigation of temporomandibular joint space of healthy adults by using cone beam computed tomography. Journal of Peking University Health sciences. 2007; 39: 503–506.

17. Torres, M. G., Crusoé-Rebello, I. M., Rosário, M., Albuquerque, M. C. & Campos, P. S. Morphometric features of the mandibular condyle and association with disk abnormalities. Oral Surg Oral Med Oral Pathol. Oral Radiol. 121, 566–72 (2016).

18. Alam MK, Ganji KK, Munisekhar MS, Alanazi NS, Alsharif HN, Iqbal A, Patil S, Jamayet NB, Sghaireen M. A 3D cone

beam computed tomography (CBCT) investigation of mandibular condyle morphometry: Gender determination, disparities, asymmetry assessment and relationship with mandibular size. Saudi Dent J. 2021 Nov;33(7):687-692.

19. Al-koshab M, Nambiar P, John J (2015) Assessment of Condyle and Glenoid Fossa

Morphology Using CBCT in South-East Asians. PLoS ONE 10(3): e0121682.

20. Coogan JS, Kim DG, Bredbenner TL, Nicolella DP. Determination of sex differences of human cadaveric mandibular condyles using statistical shape and trait modeling. Bone. 2018 Jan;106: 35-41

21. Ceratti C, Maspero C, Consonni D, Caprioglio A, Connelly ST, Inchingolo F, Tartaglia GM. Cone-Beam Computed Tomographic Assessment of the Mandibular Condylar Volume in Different Skeletal Patterns: A Retrospective Study in Adult Patients. Bioengineering (Basel). 2022 Mar 2;9(3):102.

22. Lo Giudice A, Rustico L, Caprioglio A, Migliorati M, Nucera R. Evaluation of condylar cortical bone thickness in patient groups with different vertical facial dimensions using cone-beam computed tomography. Odontology. 2020 Oct;108(4):669-675.

23. Rodrigues AF, Fraga MR, Vitral RW. Computed tomography evaluation of the temporomandibular joint in Class II Division 1 and Class III malocclusion patients: condylar symmetry and condyle-fossa relationship. Am J Orthod Dentofacial Orthop. 2009; 136: 199–206.

24. Cohlmia JT, Ghosh J, Sinha PK, Nanda RS, Currier GF. Tomographic assessment of temporomandibular joints in patients with malocclusion. The Angle Orthodontist. 1996; 66: 27–36.

25. Liu Q, Wei X, Guan J, Wang R, Zou D, Yu L. Assessment of condylar morphology

and position using MSCT in an Asian population. Clin Oral Investig. 2018 Sep; 22(7): 2653-2661

26. Yun JM, Choi YJ, Woo SH, Lee UL. Temporomandibular joint morphology in Korean using cone-beam computed tomography: influence of age and gender. Maxillofac Plast Reconstr Surg. 2021 Jul 5;43(1):21.