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`Morphometric Analysis of Temporomandibular Joints and Masseter Muscles in Khat Chewers Yemeni Population Using Computed Tomography

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Abstract:
Aim*: This study aimed to analyze morphologic changesofTemporomandibular Joints and Masseter Muscles in Khat Chewers Yemeni Population Using Computed Tomography (CT).*
Materials and Methods*: A descriptive analytical study was performed on 255 Yemenis subjects(128) (52.9%)were males and 127(47.1%) were females. 135 (52.9%) of them wereKhat chewers and 120 (47.1%) Non chewers.CT scan was performed for each participant in Radiology department of University of Science and Technology Hospital, Sana'a City-Yemen. The measurements of temporomandibular joints, massetermuscles and mandibular condyles obtained from axial and coronal sections, soft tissue and bone windows usingRadiAnt DICOM Viewer. The measurements were compared between Khat chewers and Non-Khat chewers and correlated with frequency and duration of Khat chewing.*
Results*: The mean and standard deviation of temporomandibular joints, masseter muscles and condylar thickness measurements were higher in Khat chewers than Non-Khat chewers with statistical significant difference (p<0.05). The width of mandibular condyles was higher in Khat chewers than Non-Khat chewers with no statistical significant difference (p>0.05). No relation between measurements andduration and frequency of Khat chewing, also there was no relation as found between dental loss and Khat chewing.*
Conclusion:*The measurements of temporomandibular joints, masseter muscles and mandibular condyles was higher in Khat chewers than Non-Khat chewers.*
Key Word*:Morphometric; Temporomandibular joints; Masseter muscles;Khat chewers;Computed Tomography.*

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I. Introduction

The Khatplant is a tree grown in Yemen and some countries of East Africa belongs to the Celastraceae family, the young fresh leaves of Khat are habitually chewed for their amphetamine like effect.Chemically the Khat mainly contain Cathine and cathinon that have amphetamine like effects(1).The Khatchewers select soft leaves and chew it slowly,the juice is swallowed and chewed material stored it in the buccal sulcus for several hours either unilaterally or bilaterally and later expectorated(2).Khat chewing is a common behavior between Yemenis population in both male and female, where the most of Khat chewers are males and do this behavior daily(3, 4).The literatures reported effects of Khat on various body systems and including hard and soft tissues of the mouth and Temporomandibular joint TMJ(1)(5). The prolonged chewing may cause TMJ pain and muscles hypertrophy due functional demand(1).Computed Tomography scan considered as excellent and preferred imaging modality for evaluation and visualization of mandible and surrounding soft tissues in addition to dentation and dental roots(6)(7)(8).CT also play an important role in imaging of TMJ and detect several disorders associated with TMJ(9). There are no previous literatures in Yemen that dealt with morphologic effect of Khat chewing on TMJ and masseter muscles.The knowledge about the Khat effects about such structures of TMJ and

masseter muscles regarding to the duration and frequency of Khat chewing will contribute in reducing the effects result from Khat chewing.

II. Materialsand Methods

This analytical case controlstudy was conducted in Radiology department at University of Science and Technology Hospital, Sana'a City-Yemen.The population contributed in this study collected from Yemeni populationwho admitted to radiological department and underwentCT examination for the head or neck including TMJ and masseter muscles. During period from November 2017 to January 2020. A sample of255 of adult Yemeni patients with different agesincluding both genders males and females 128 (52.9%) males and 127(47.1%) females.Khat chewers was 135 (52.9%) and Non-Khat chewers were 120 (47.1%). The adult Khat chewers was 84 (62%)males and 51 (38%) females.

Inclusion criteria:

1. Patients who agreed to participate in this study.
2. Khat chewers Non-Khat chewers Patients with normal mandible, TMJ and masseter muscles.
3. Adult Yemenis people

Exclusion criteria:

1. Non- adult peoples &Non-Yemenis people.
2. Patients with congenital anomalies of mandible,TMJ and masseter muscles.
3. Traumatic patients.
4. Patientswith previous surgery or disease affecting normalmorphology of TMJand masseter muscles.

Study Procedures

After explaining the nature and aims of this study verbal consent was obtained from the patients to take their data, the patients data were collected using a data collection sheet whichdivided into two parts.**Part I:**Demographic characteristics of the patients which include:Age,Gender, Khat chewing, Side of Khatchewing, Duration of Khat chewing (Hours per day,Days per week and Number of years from the beginning of Khat chewing), Dental lose and side of Dental lose.**Part II:**Measurements parameter including:TMJ space Height, Mandibular condyles (widthand thickness) and Width of Masseter muscles.The patients subjected to computed tomography scan for head or neck region including area of TMJ and Masseter muscles with different scanning parameters varies according to the type of exam such as (Maxilla facial, PNS, cervical spine etc…).The images were reconstructedto thin slices with same reconstruction parameters to produce high quality images to obtain measurements of theTMJ space Height, Mandibular condyles (width & thickness) and Width of Masseter muscles byRadiAnt DICOM Viewer.

The TMJ space Height measured from coronal section bone window at the level of mid mandibular condylesfrom highest point of condylar head to the deepest point of articular fossa. Themeasurements were taken depending on the method mentioned by Rozylo et al.[(10)]Figure(1).Where the measurements of Mandibular condyles (width and thickness) obtained from axial section bone window at the level of maximum width of mandibular condyles, from most medial point to the most lateral point and most from the most anterior point to the most posterior point.The measurements were taken depending on the method mentionedbyJablonski et al[(11)]Figure(2). TheWidth of Masseter muscles measured from axial section soft tissue window at the level of mandibular foramen corresponding to the maximum thickness of masseter muscles from superficial fascia of masseter muscle and the lateral surface of the ramus.The measurements were taken depending on the method mentioned byPremkumar et al[(12)]Figure(3)**.**These measurements reviewed and confirmed by consultant radiologist and other specialists relevant to the radiology for further accuracy.

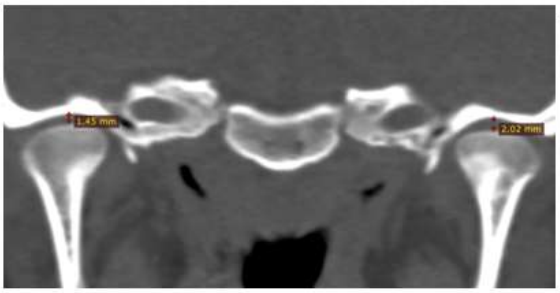

Figure (1): Coronal section bone window shows TMJ space measurements.

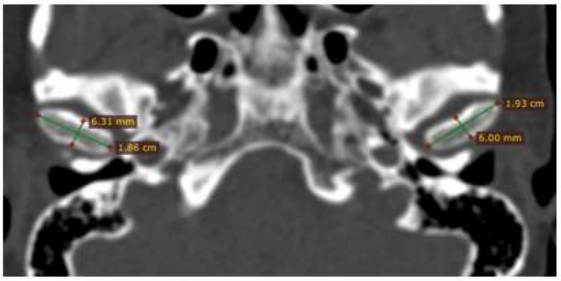

Figure (2): Axial section bone window shows Mandibular condyles (width & thickness)measurements.

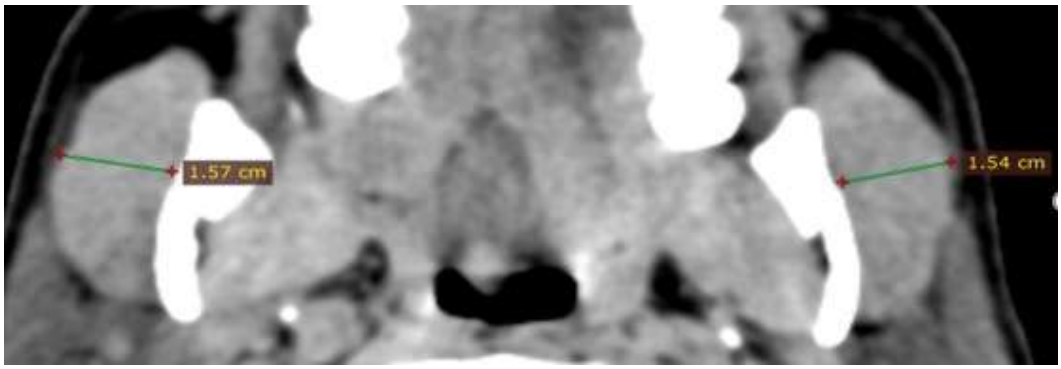

Figure (3): Axial section soft tissue window shows measurements of the Masseter muscles width.

Statistical analysis

The data were analyzed using SPSS program version 24.00.0. The data were presented in the form of tables, where the t-test, ANOVA test, and Chi-square were carried out test of statistical significance at α-level of 0.05.

III. Results

Table1:shows distribution of study sample according to sociodemographic data.

	Age class	Number	Percent %	Total
Age	19-30	83	32.5 %	255
	31-40	48	18.8 %	
	41-50	64	25.1 %	
	51-60	33	12.9 %	
	>60	27	10.6 %	
Gender	Male	128	50.2 %	255
	Female	127	49.8 %	
Khat chewing	Chewer	135	52.9	255
	Non -chewer	120	47.1	
Khat chewing according to gender	Male chewer	84	62.2 %	135
	Female chewer	51	37.7 %	
Side of Khat chewing	Right side	47	18.4 %	135
	Left side	67	00026.3 %	
	Bilateral	21	8.2 %	
Durationof Khat chewing per hours	1-3	57	22.4 %	135
	4-6	54	21.2 %	
	>6	24	9.4 %	
Frequencyof Khat chewing per week.	1-2	14	5.5 %	135
	3-4	14	5.5 %	
	>4	107	42.0 %	
Durationof Khat chewing per years	1-10	62	24.3 %	135
	11-20	43	16.9 %	
	21-30	22	8.6 %	
	>30	8	3.1 %	

Table 2: Temporomandibular joints and masseter muscles measurements in Khat chewers and non- Khat chewers.

TMJ & Masseter Muscles Measurement (mm)		Khat chewing						Significant test
		Khat chewers			Non-Khat chewer			
		Mean±SD	Maximum	Minimum	Mean±SD	Maximum	Minimum	
TMJ space height	Right	1.78±0.98	5	0.1	1.34±0.87	3.8	0.1	0.000
	Left	1.90±0.98	4	0.1	1.35±0.81	3.4	0.1	0.000
Masseter muscles	Right	11.8±2.69	20	6	9.8±2.55	18	0.8	0.000
	Left	12±2.70	21	6	9.9±2.37	18	1	0.000
Right Mandibular condyles	Width	18.4±2.08	24	12	17.5±1.97	22	13	0.000
	Thickness	7.6±1.65	16	4	7.3±1.66	16	4	0.199
Left Mandibular condyles	Width	18.1±2.18	24	12	17.2±2.19	22	13	0.002
	Thickness	8.1±1.45	14	3	8.0±1.66	16	4	0.364

Table 3: Temporomandibular joint and masseter muscles measurements regarding to side of Khat chewing.

TMJ & Masseter Muscles Measurement (mm)		Side of Khat chewing			Significant test
		Right	Left	Bilateral	
		Mean±SD	Mean±SD	Mean±SD	
TMJ space height	Right	2.02±1.13	1.70±0.86	1.51±0.846	0.085
	Left	2.11±1.02	1.85±0.94	1.62±0.954	0.135
Masseter muscles	Right	12.02±2.73	11.74±2.58	11.47±3.01	0.704
	Left	12.00±2.56	12.16±2.67	11.85±3.27	0.889
Right Mandibular condyles	Width	18.29±1.93	18.35±1.88	19.2±2.86	0.188
	Thickness	7.78±2.06	7.59±1.77	7.57±2.01	0.807
Left Mandibular condyles	Width	17.9±2.06	18.0±2.06	18.7±2.75	0.406
	Thickness	8.10±1.25	8.25±1.44	8.09±1.89	0.836

Table 4: Temporomandibular joint and masseter muscles measurements in adult Khat chewer regarding to duration of Khat chewing per hours in day.

TMJ & Masseter Muscles Measurement (mm)		Duration per hours			Significant test
		1-3 hours	4-6 hours	>6 hours	
		Mean±SD	Mean±SD	Mean±SD	
TMJ space height	Right	1.8±1.04	1.6±0.93	1.9±0.91	0.488
	Left	2.0±0.95	1.7±0.89	1.8±1.2	0.323
Masseter muscles	Right	11±2.65	12.2±2.67	12.5±2.51	0.026
	Left	11.2±2.44	12.5±2.98	12.8±2.33	0.018
Right Mandibular condyles	Width	17.9±1.84	18.8±2.10	19.0±2.34	0.025
	Thickness	7.9±1.35	7.2±1.51	7.8±2.34	0.070
Left Mandibular condyles	Width	17.6±2.13	18.4±2.19	18.5±2.16	0.110
	Thickness	8.5±1.36	7.8±1.38	8.0±1.66	0.055

Table 5: Temporomandibular joint and masseter muscles measurements in adult Khat chewer regarding to frequency of Khat chewing per days in week

TMJ & Masseter Muscles Measurement (mm)		Frequency per weeks			Significant test
		1-2 days	3-4 days	>4 days	
		Mean±SD	Mean±SD	Mean±SD	
TMJ space height	Right	1.5±1.04	1.5±0.83	1.8±.98	0.336
	Left	1.7±0.90	1.9±0.93	1.9±1.00	0.846
Masseter muscles	Right	11.7±1.81	10.2±1.84	12.0±2.82	0.059
	Left	11.8±2.17	10.7±1.63	12.2±2.85	0.129
Right Mandibular condyles	Width	18.6±1.82	18±2.14	18.5±2.12	0.656
	Thickness	7.5±145	7±0.99	7.7±7.39	0.323
Left Mandibular condyles	Width	17.8±1.95	18.1±2.24	17.2±2.19	0.877
	Thickness	8±0.99	7.5±0.93	8±1.66	0.231

Table 6: Temporomandibular joint and masseter muscles measurements in adult Khat chewer regarding to duration of Khat chewing per years.

TMJ & Masseter Muscles Measurement (mm)		Duration per years				Significant test
		1-10 years	11-20 years	21-30 years	>30 years	
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	
TMJ space height	Right	1.6±0.92	1.8±1.11	2±0.87	1.3±071	0.254
	Left	1.7±0.92	1.9±1.10	2.2±0.95	2±0.45	0.230
Masseter muscles	Right	12±2.49	12±2.54	11.6±3.27	9.2±2.31	0.045
	Left	12.1±2.42	12.4±2.86	11.9±2.93	9.7±2.86	0.078
Right Mandibular condyles	Width	18±2.07	18.7±1.87	18.5±2.15	19.8±2.53	0.075
	Thickness	7.4±1.64	7.6±1.68	8.4±1.65	7.5±1.06	0.106
Left Mandibular condyles	Width	17.8±1.98	18.3±2.17	18.2±261	18.8±2.53	0.559
	Thickness	7.9±1.29	8.2±1.44	8.4±1.56	9±2.07	0.142

Table 7: Correlation between Khat chewing and dental loss**.**

Khat chewing	Dental loss		Total	Percent%	Correlation
	Yes	No			
Chewer	73	62	135	52.9%	r= 0.049 p=0.436
Non-chewer	59	61	120	47.1%	
Total	132	123	255	100%	

Table 8: Correlation between side of Khat chewing and side of dental loss.

Side of chewing	Side of dental loss			Total	Percent%	Correlation
	Right	Left	Both			
Right side	5	12	10	27	37%	r=0.146 p=0.019
Left side	8	8	17	33	45.2%	
Both side	1	2	10	13	17.8%	
Total	14	22	37	73		

VI. Discussion

The present study showed that the most frequently age group ranged from 19 to 45 years(32.5 %), including both genders128 (52.9%) were males and 127(47.1%) were females. The Khat chewers were135 (52.9%) and 120 (47.1%) were Non-Khat chewers. The malesKhat chewers were larger than females, 84 (62%) were males and 51 (38%) were females.The most Khat chewers used left side of mouth 26.3%, for 1-3 hours per day 22.4%, more than 4 days per week 42% and 1-10 years is most frequent duration per years 24.3%.Similar to the finding reported by Bakhadher,Nakajima, Numan and Wedegaertner et.al who found that, the males tend to used Khat for longer duration and more frequently than females, and most Khatchewers usedKhat in left side, more than 5 hours per days,more than 5 days per weeks and for 1-11 years[(3)(4)(13)(14)]. Comparing Temporomandibular joints and masseter muscles measurements betweenKhat chewers and non- Khat chewers, theKhat chewers showed larger measurements than non Khat chewers in temporomandibular joints space and masseter muscles with statistical significant difference p=0.000. The above finding supported by Tiwari et.al (2017) who mentioned that, the chewing side preference has a detrimental effect on the TMJ of the corresponding side and is also related to lateral facial asymmetry[(15)]. And Jiang et.al (2010), who conclude that, the right chewing-side preference affects the morphology of temporomandibular joint[(16)].The bulky muscles are associated with physical activity, were the training and activity lead to hyper atrophy and inactivity lead to hypotrophy [(17)]. Also the masseter muscles hypertrophy is associated by hyper function result from bruxism as mentioned by Ahlgren et.al (1969)[(18)].

The width and thickness of mandibular condyles in Khat chewer were larger than NonKhat chewer with statistical significant difference in condylar thickness $p<0.05$, and no statistical significant difference in condylar width p=0.110for right and left side. The results of the present study seem to be in parallel with the result of a study by Manja et.al (2019) who concluded that, there is a statistical significant difference in the average height of the mandibular condyle and articular eminence shape,but there is no significant difference in the width of the mandibular condyle[(19)].Beside to the functional factor there are other factors affecting mandibular condyles size and shape such as: different types of condyles were the mandibular condyles categorized into five basic types. Genetic, developmental variation, age groups, and individuals play a role in morphologic changes in size and shapes of condyles as mentioned byHegde et.al (2018)[(20)].

In correlation between TMJ space height, masseter muscles width and mandibular condyle width and thickness with side of khat chewing the bilateral chewers showed smaller measurements than single side chewers withno statisticalsignificant difference between right side chewer, left side chewer and bilateral chewersp>0.05. the above results indicate that the effect is larger in single side Khatchewers than bilateral Khat chewers.Similar to the result concluded by Farias et.al (2010) who found masticatory performance is not correlated to a defined mandibular movement pattern, which did not differ between bilateral and unilateral chewers[21].Several studies correlate mandibular changes and symptoms with harder food such as Komino et.al (2017), who mentioned the changes of mandibular movements is related to the different level of food hardness[22].The effect on the TMJ in not related to the preferred chewing side only but also to the types of food as mentioned by Ratnasari et.al (2011) who found the anterior disc displacement appear only in the ipsilateral hard food chewer and no correlation between anterior disc displacement unilateral soft food chewers[23]. Moreover, Kurnia et.al (2018), conclude that no correlation between the chewing preference with condylar asymmetry in patients with TMD**[24]**. Zamanlu, et.al (2012) also Saied that the laterality in mastication is more explicit when using hard food**[25]**.The no affection of Khat chewing was return to the nature of Khat leaves which is soft as mentioned earlier. Comparing temporomandibular joints space height, masseter muscles width and mandibular condyles width and thickness with duration of khat chewing per hours in day, frequency of khat chewing per days' in week and duration per years there was no statistical significant difference between measurements regarding to the duration and frequency of khat chewingp>0.05. The previous finding indicate the effects may appear when more than one factors meet together such as: more frequency of Khatchewingwith longer duration per hours in days for several years. As mentioned by Astatkie et.al (2017),oral symptoms in regular long term khat chewer is 50% more than those who were not long-term chewers[26].

Regarding to the dental loss, the Khat chewers show dental loss more than Non-chewers with no statistical significant relation between dental loss and Khat chewing were R= 0.426. Also no relation between side of dental loss and side of Khat chewing were R=0.437. The previous results are in accordance to the results by Al- Bayaty et.al (2011) who studied Tooth mortality in khat and non khat chewers in Sana'a Yemen, and conclude, the mean teeth loss increased with age in both khat chewers and non- khat chewers, no significant difference between male khat and non- khat chewers but there was a significant difference in teeth loss between female khat chewers [27].

IV. Conclusion

In conclusion the Khat chewing causes hyper-atrophy of masseter muscles and widening of TMJ, were the temporomandibular joints, masseter muscles and mandibularcondyles measurements were higher in Khat chewers than Non-Khat chewers.No relation betweenmeasurementswith duration and frequency of Khat chewing. Also there was no relation between dental loss and Khat chewing.

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