

Evaluation of Masseter Muscle Thickness among Iraqi Adult Subjects with Dentate and Unilateral Partial Edentulism: An Ultrasonographic Study

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Abstract

Background: Mastication muscles and teeth functions play a very significant role in the equilibrium of occlusal and its function. Masseter muscle is considered the most observable of mastication muscles, which is regarded as one of the action signs of jaw muscle. **Objective:** The measurement and evaluation of masseter muscle thickness and compare it among dentate and unilateral partial edentulism by noninvasive ultrasonographic imaging technique was designed by the current study. **Materials and Methods:** Forty Iraqi persons were used as samples for the current study. The age range was from 18 to 48 years. The study groups are controlled dentate group 10 for each male and females and unilateral partial edentulism group 10 for each male and females. Masseter muscle thickness was measured through ultrasonography in Babylon Training Center for Primary Health Care/Ultrasonographic Department, in contraction and rest situations for two sides. **Results:** The thickness of the masseter muscle for both groups was significantly different ($P < 0.05$). The differences were highly significant under occlusion and rest situations among males and females ($P < 0.05$). However, when comparing the control and dentate groups among males and females was no difference in the thickness of muscle ($P > 0.05$). The differences occurring during the thickness of masseter muscle evaluation between the control and an edentulous group according to gender were statistically significant ($P < 0.05$). **Conclusion:** Ultrasonographic scanning is an important imaging procedure for accurately measuring the thickness of the masseter muscle, and the atrophy of the masseter muscle was proofed on the edentulous side.

Keywords: Dentulous, skeletal morphology, thickness of masseter muscle, ultrasonographic scanning, unilateral partial edentulism

INTRODUCTION

Mastication muscles and teeth represent the main task in keeping the balance of occlusal.^[1-3] The most obvious of mastication muscles is a masseter muscle because the muscle is the most superficial and strongest one. The action of the jaw muscle is affected by the thickness of the muscle.^[3] The muscle fiber size and composition could be affected by prolonged bilateral differences in teeth number, which affects muscle work and in turn affects jaw muscle activity and this may create alterations in the muscle thickness due to an asymmetric exercise stimulation action.^[4-7] In addition, the muscle fibers will be affected with the progress of age as a loss in the force

of muscle fibers, as well as the closing force of the jaw, will increase with age (20–50) years and then decline.^[8]

The dentate side is habitually used by subjects with unilateral partial edentulous due to the highest contacts of teeth through lateral gliding, and this occurs in the dentate side where the most of chewing process occurs.^[4] Now, the measurement of the cross-section and human

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jaw muscle thickness is possible by using ultrasonography (US), computerized tomography (CT), and magnetic resonance imaging (MRI). The soft and hard tissue can be visualized by CT but it has shortcomings in the muscle imaging. While the muscle morphology is displayed by MRI, its time and cost are higher than CTs. Therefore, the US is considered an easy a suitable technique for muscle evaluation.^[9,10]

In 1976, muscle size was directly measured by the US, which was first used in living human subjects as an imaging technique.^[10,11] Therefore, the examination of muscles was carried out using the US, specifically for the muscle groups, which are large and superficial.^[1,8]

Ultrasound was considered as nonionizing radiation, and its energies and doses have no harmful effects, furthermore, this technique is low cost and broadly available, rapid, and is a more accurate and reproducible method for measurements.^[1,12] The several densities of image exhibited on the screen in the white/black echoes and explained as hypoechoic (dark) or hyperechoic (light).^[13]

The successful evaluation of dynamic functions of tendon and muscle motion can be done by ultrasound. In addition, biomechanical studies in a clinical or laboratory field, it is considered a complementary methodological line. Therefore, the quantification techniques of the kinematics of muscle from ultrasound images are being progressed depending on image processing.^[14]

The present study measures and compares the thickness of masseter muscle among males and females (control, dentate, and edentulous) in relaxation and contraction

situations using a noninvasive ultrasonographic imaging technique.

MATERIALS AND METHODS

A prospective study of ultrasonographic scans was taken for 40 Iraqi persons (20 males and 20 females) were used as samples for the current study. The age range was from 18 to 48 years. The collected sample in our study included patients who attended the Prosthodontic Department at Specialized Second Dental Center. A study description procedures criteria was given to subscribers and if they accept it then requested to sign an informed consent. Masseter muscle thickness was measured by ultrasonography at Babylon Training Center for Primary Health Care/Ultrasonographic Department, in occlusion and rest situations for two sides, the examination was done in supine position, so the fiber of the muscle will be a normal physiological position and thickness.^[8]

Distribution of sample

As shown in Figure 1, the subjects were divided into two groups:

Group A (control): contains 10 males and 10 females, with full dentition left and right.

Group B (case): consists of 10 males and 10 females, without extraction from one side called the dentate side and the other side has tooth extraction either maxilla with partial edentulous area (lost teeth #15, #16, #17/#25, #26, and #27) or mandible with partial edentulous area (lost teeth #45, #46, #47/#35, #36, and #37). The excluded patients from this study are those with bilateral partial edentulism.

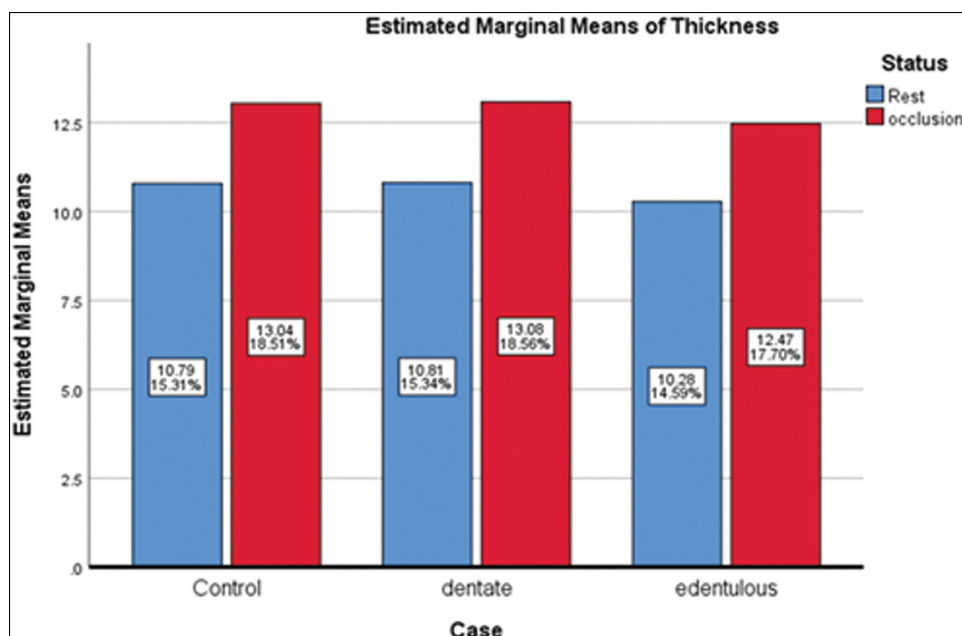


Figure 1: Explain the distribution of variables in the current study

A high-resolution ultrasound real-time linear transducer was used in the thickness evaluation of the masseter muscle (11L/Voluson E6, the ultrasonographic device was used in this study is Philips, serial number: usd 10781028, 2011, and the transducer used for scanning is linear transducer (L 12-3) and its frequency ranging from 3 to 12 MHz).

The inclusion criteria of sample selection

The inclusion criteria of sample selection are as follows:

1. participants should be free from any index of extreme body mass;
2. participants should be free from problems in temporomandibular joint, which include osteoarthritis and rheumatoid arthritis;
3. all the participants should be asked about the left and right chewing sides, to ignore the masseter muscle hypertrophy on the chewing side;
4. participants should be without crowding, spacing, reversed overjet, crossbite, and deep bite; and
5. bruxism and clenching or any history of abnormal habits should be excluded.

Ultrasonographic scanning of patients' preparation

The measuring of muscle thickness by millimeters ultrasonographically was done by a high-resolution real-time linear transducer by putting the participant in a supine position with gently rotating his/her head to display the area that needed to be measured. The probe was covered by a water-based gel after holding the transducer perpendicularly to the skin surface without any excessive pressure then the application of the probe was at a halfway point between the gonial angle and zygomatic arch, which is considered the greatest thickness part of the masseter muscle. Under rest and maximum clenching situations, the imaging and measurements were accomplished bilaterally as shown in Figures 2 and 3.

Statistical analysis

Statistical Package for Social Sciences (SPSS version 21, IBM Corporation, Armonk, NY, USA) was used to analyze the data. The significant differences between variables were measured using the independent-sample *t* test. For analysis of variance models, the effect of size

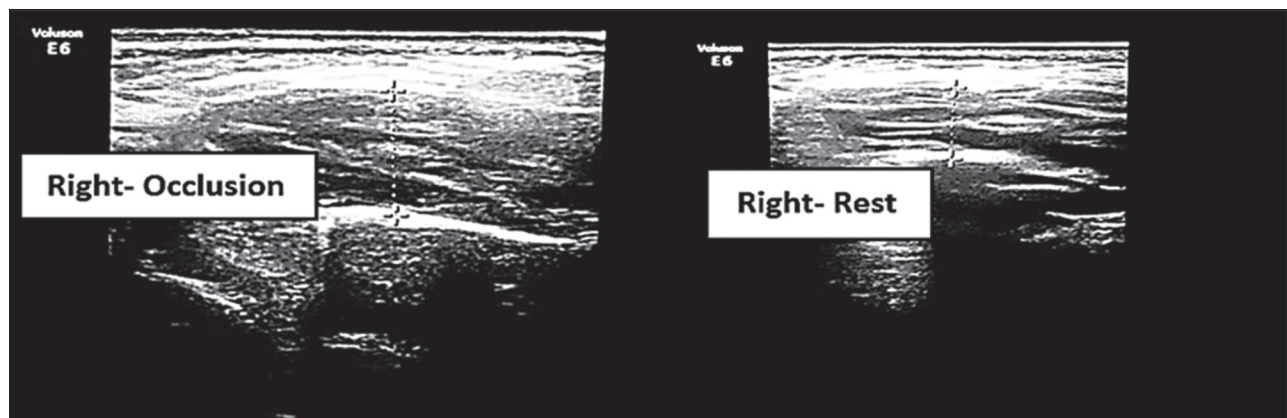


Figure 2: Right thickness of masseter muscle scanning measured in (mm) under occlusion and rest situations

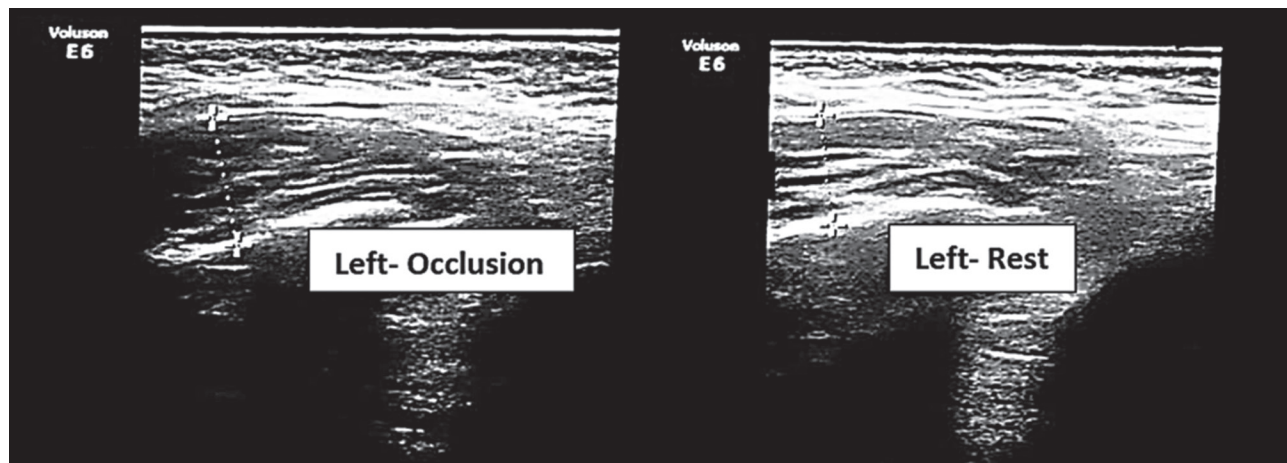


Figure 3: Left thickness of masseter muscle scanning measured in (mm) under occlusion and rest situations

was measured using eta squared (η^2). The estimation of effect size is a standardized way, which means that it is comparable through result variables measured using various units.

Ethical approval

On January 5, 2023, the University of Babylon/College of Dentistry's Institutional Review Board Committee 5499 gave its clearance for this project. Every participant gave their informed consent.

RESULTS

Table 1 shows the distribution of variables in the current study.

Table 2 shows the gender effect on the masseter muscle's width. Variation of gender showed a significant difference in masseter muscle's width through occlusion as well as rest situations ($P < 0.001$).

Table 1: Frequency of variables			
	Variables	Frequency	Percentage (%)
Gender	Female	80	50.0
	Male	80	50.0
	Total	160	100.0
Status	Rest	80	50.0
	Occlusion	80	50.0
	Total	160	100.0
Case	Control	80	50.0
	Dentate	40	25.0
	Edentulous	40	25.0
	Total	160	100.0

The results of the thickness of masseter muscle in occlusion and rest situations presented a great significant difference between them ($P < 0.001$) as shown in Table 3.

The results of the thickness of the masseter muscle showed nonsignificant differences among control and dentate groups ($P \geq 0.05$) as shown in Table 4.

In addition, the thickness of masseter muscle among control and edentulous groups is presented in Table 5 and there is a significant difference between them ($P < 0.05$).

DISCUSSION

The masseter muscle thickness as shown in Table 2 is much thicker among males compared with females, this is the fact due to the big difference in thickness of masseter muscle among people. Several elements have been suggested for an explanation of the difference between individuals in the kind of fiber composition of the muscle of the skeleton. Part of them is associated with genetic factors, physical activity level, and an effect of gender hormones.^[1,15]

Masseter muscle thickness is much thicker under contraction conditions when compared to rest conditions this was explained in 1954 by the *theory of Huxley's sliding filament*, the main opinion behind the shrinkage of muscle is the myosin and actin filaments overlapping. The basic unit that controls the changing in length of muscle is a sarcomere, within the sarcomere, the muscle fiber contracted in a procedure, which needs adenosine triphosphate by gliding the myosin, which is thick filaments along actin, which is thin filaments.^[1,4,15]

There is no significant difference between the control and dentate groups, this is a fact due to the normal physiology

Table 2: Relation between gender and thickness of muscle								
Thickness	Number	Mean	Standard deviation	Standard error	Minimum	Maximum	P value	η^2
Female	80	11.468	1.0974	0.1227	9.7	13.3	0.001*	0.067
Male	80	12.100	1.2700	0.1420	10.1	13.7		
Total	160	11.784	1.2249	0.0968	9.7	13.7		

η^2 equals 0.01 means lesser influence.

η^2 equals 0.06 means moderate influence.

η^2 equals 0.14 means great influence.

*High significance differences ($P \leq 0.001$)

Table 3: Relation of the thickness of masseter muscle under occlusion and rest situations								
Thickness	N	Mean	Standard deviation	Standard error	Minimum	Maximum	P value	η^2
Rest	80	10.663	.3746	0.0419	9.7	11.3	0.000**	0.843*
occlusion	80	12.905	.5772	0.0645	11.8	13.7		
Total	160	11.784	1.2249	0.0968	9.7	13.7		

η^2 equals 0.01 means lesser influence.

η^2 equals 0.06 means moderate influence.

η^2 equals 0.14 means great influence.

*Significance differences ($P \leq 0.001$).

**High significance differences ($P \leq 0.001$)

Table 4: Masseter muscle's width among control and dentate groups

Variables	N	Mean	Standard deviation	Standard error	Minimum	Maximum	P value	η^2
Control	80	11.911	1.2171	0.1361	10.2	13.7	0.903	0.03
Dentate	40	11.940	1.2272	0.1940	10.2	13.7		
Total	120	11.921	1.2154	0.1109	10.2	13.7		

η^2 equals 0.01 means lesser influence.

η^2 equals 0.06 means moderate influence.

η^2 equals 0.14 means great influence.

Table 5: Masseter muscle width among control and edentulous groups

Variables	N	Mean	Standard deviation	Standard error	Minimum	Maximum	P value	η^2
Control	80	11.911	1.2171	0.1361	10.2	13.7	0.022	0.27
Edentulous	40	11.373	1.1741	0.1856	9.7	13.1		
Total	120	11.732	1.2248	0.1118	9.7	13.7		

and function resulting from the greatest number of teeth contacts during chewing, so the harmonious working of teeth and muscles will produce an equilibrium in occlusion.^[16]

The significant difference between the edentulous side when compared with a control group is due to atrophy in the masseter muscle, this is due to loss of equilibrium during teeth or muscle chewing deviation as of usual function and physiology. Suit *et al.*^[17] stated that “when teeth are missing, people shift the chewing on the side that has highest contacts of teeth through lateral gliding movements and due to the mastication load distribution is unequal bilaterally.” Therefore, loss of teeth produces atrophy in muscles of mastication.^[1,18,19]

CONCLUSIONS

Ultrasonographic scanning is an important imaging procedure for accurately measuring the thickness of the masseter muscle, and the atrophy of the masseter muscle was proofed on the edentulous side.

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Conflicts of interest

There are no conflicts of interest.

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