ORIGINAL RESEARCH

Correlation of Masseter Muscle Thickness and Intermolar Width - An Ultrasonography Study

Saritha Tircoveluri[1], Johar Rajvinder Singh[2], Naveen Rayapudi[1], Arjun Karra[3], Mohammadi Begum[4], Padmalatha Challa[5]

[1]Senior Lecturer, Department of Orthodontics, Mamata Dental College, Khammam, Andhra Pradesh, India; [2]Senior Lecturer, Department of Orthodontics, Chhattisgarh Dental College, Rajnandgaon, Chhattisgarh, India; [3]Senior Lecturer, Department of Orthodontics, Army College of Dental Sciences, Secunderabad, Andhra Pradesh, India; [4]Senior Lecturer, Department of Orthodontics, Drs. Sudha and Nageshwara Rao Pinnamineni Sidhartha Institute of Dental Sciences, Gunnavaram, Vijayawada, Andhra Pradesh, India; [5]Professor & Head, Department of Orthodontics, Mamata Dental College, Khammam, Andhra Pradesh, India.

ABSTRACT

Background: To determine the association between the thickness of masseter muscle and the maxillary dental arch width. To explore the influence of gender on masseter muscle thickness.

Materials & Methods: Seventy subjects (35 females and 35 males) of age 18 to 25 years were selected for the study based on class I molar relationship. The masseter muscle thickness of the right and left sides in every subject were found out through ultrasound scanning of the muscle, in both relaxed and clenched states. The maxillary dental arch width was measured on the study model with an electronic caliper. Student t test, Pearson's Correlation Coefficient was performed to assess the sample.

Results: Masseter Muscle Thickness showed a positive correlation with Maxillary Dental Arch Width r ≤0.74. The masseter muscle thickness is greater in male subjects in both relaxed ($0.001<p<0.00$) and contracted state.

Conclusion: Masseter muscle thickness influences the growth of the jaws. Increase in masseter activity leads to an increased growth in transverse and sagittal dimensions, and decreased growth in vertical dimension.

Key words: Masseter Muscle Thickness, Maxillary Dental Arch Width, Ultrasound.

How to cite this article: Tircoveluri S, Singh J R, Rayapudi N, Karra A, Begum M, Challa P L. Correlation of Masseter Muscle Thickness and Intermolar Width - An Ultrasonography Study. *J Int Oral Health 2013; 5(2):28-34.*

Source of Support: Nil **Conflict of Interest:** None Declared

Received: **13th December 2012** Reviewed: **31st January 2013** Accepted: **22nd February 2013**

Address for Correspondence: Dr Saritha Tircoveluri. Senior Lecturer, Department of Orthodontics, Mamata Dental College, Giri Prasad Nagar, Khammam – 507002, Andhra Pradesh. India. Contact No.: 9652117340. E mail: sarithavenu9@yahoo.com

Introduction

The effects of muscle thickness on bone morphology can be explained by a theory which is recognized in the field of biodynamic as Wolff's law. This law points out that the internal structure and the shape of bone is closely related to function, and defines a relationship between bone shape and muscle function. In order to describe facial morphology, the structure of the facial muscles should be investigated thoroughly to determine the pattern of interaction of the skeleton and muscles[1].

The significance of masticatory muscle function on the basic mechanisms of craniofacial growth has been illustrated in various animal experimental studies. Clinical studies, mostly

performed in adults have shown the relationship between craniofacial morphology and masticatory muscle function, estimated by recording the bite

Fig. 1: Ultrasound machine used in the study.

force, the electromyographic (EMG) activity of these muscles, or by measuring the cross-sectional thickness by means of computed tomography, magnetic resonance imaging (MRI) and ultrasonography. Despite the different techniques of measuring the functional characteristics of these muscles, the aforementioned studies clearly indicate a significant association between the masticatory muscles and the vertical as well as the transverse craniofacial dimensions.[2]

Fig. 2: Ultrasonographic image in right relaxed and contracted states.

Objective of the study :

Aim:

To compare the relation between the masseter muscle thickness and intermolar width.

Objectives:

- Influence of masseter muscle thickness on the maxillary intermolar width.
- Association of masseter muscle thickness to the gender of the subjects.
- Association of maxillary dental arch to the gender of the subjects.

Materials and Methods:

The sample comprised of 70 subjects (35 females and 35 males) randomly selected in the age group of 18 to 25 years. The subjects were selected according to their Class I molar relation and with minimal or no malocclusion in the anterior segment.

The masseter muscle thickness of the right and left sides were found out through ultrasound scanning of the muscle using the 10.5 MHz Ultrasound Scanner and Probe (My Lab, Esoate

Fig 3: Ultrasonographic images during right relaxed and contracted states obtained after 5 minutes.

Inc, Italy) (Fig.1). The muscle thickness was measured in both relaxed and clenched states. This scanning was repeated after 5 minutes to reduce the measuring errors (Fig 2,3). This gave a total reading of eight. Then the means were calculated.

The patient was asked to clench his teeth to make the muscle evident and its outline marked using an erasable felt pen, on both the sides. The center of the muscle was marked at the intersection of the two diagonals. The conductive gel was applied evenly on the marked spot using a gauze pad. The subject was seated in an upright position, with the head in natural posture.[1]

Natural posture was standardized, by making the patient to look at a distant object placed at 6 feet distance. The patient was asked to relax and get his/ her posterior teeth together. The ultrasound probe was placed on the mark. The angle of the probe was adjusted to produce the strongest echo from the mandibular ramus, achieved when the scan plane was perpendicular to its surface.[3] The muscle ultrasound image was recorded in the relaxed state. The patient was asked to clench his/her teeth, and the muscle ultrasound image was recorded in the contracted state. The same procedure was repeated on the other side. After a five minutes interval the above procedure was done again, to minimize the intraexaminer error. The measurement of the masseter muscle was directly made at the time of scanning, with a read out of the distance to the nearest 0.1 mm. Alginate impressions of the subjects were made and their maxillary casts obtained. Using digital calipers the distance between the palatal surfaces of the maxillary first molars from the greatest height of contour was measured (Fig.4). This gave the intermolar width in maxilla.[4]

Student t test was performed to determine the comparison of means in male and female subjects. Pearson's correlation coefficient was used to assess the relation of intermolar width and masseter muscle thickness in both

Results: Masseter muscle thickness showed a positive correlation ($0.611 < r < 0.746$) with Maxillary Dental Arch Width in both contracted and relaxed states. This indicates that Masseter muscle thickness and Maxillary dental Arch Width are directly proportional, i.e. as one increase the other also increases. There was a positive linear correlation between masseter muscle thickness and Maxillary dental arch width, in both males and females. The mean thickness of masseter muscle was greater in men than women in both contracted and relaxed states. The Maxillary inter molar width in men was larger than in women (Table – 4).

Fig 4: Measuring the intermolar width.

Discussion

Moss and Salentijn hypothesized that human facial growth occurred as a response to functional needs and was mediated by the soft tissues. It is generally accepted that the shape of the face is determined by both genetic influences and local environmental factors.[5]

The growth of jawbones is mainly influenced by the activities of the muscles of mastication, out of which the masseter is said to have the major influence. The masseter acts on the transverse

growth of the mid face and vertical growth of the mandible. Studies have shown an association between the functional capacity of the masticatory muscles and craniofacial morphology.[4]

muscle thickness.[7] The thickness of masseter muscle is a direct indication of its activity. Thicker the muscle the more active it is.[4] The interaction between the masticatory muscles and the

Table 1: Correlation between intermolar width and thickness of masseter muscle in relaxation and contraction			
		Masseter relaxed	**Masseter contracted**
Inter molar width	Pearson Correlation coefficient	0.611	0.746
	Sig. (2-tailed)	.000	.000
	N	70	70

Table 2: Thickness of masseter muscle in relaxation among males and females					
	Gender	**N**	**Mean**	**Std. Deviation**	**Student t test P***
Masseter relaxed	**Males**	35	11.6140	.74922	0.00
	Females	35	12.5017	.46138	

Table 3: Thickness of masseter muscle in contraction among males and females.					
	Gender	**N**	**Mean**	**Std. Deviation**	**Student t test P**
Masseter contracted	**Males**	35	13.5349	.88009	0.00
	Females	35	12.5017	.56516	

Table 4: Inter-molar width among males and females.					
	Gender	**N**	**Mean**	**Std. Deviation**	**Student t test P***
Student t test P*	**Males**	35	35.42	1.27535	0.00
	Females	35	31.93	1.13339	

Increased masseter muscle activity has been associated with an increase in maxillary dental arch width. Numerous experimental and clinical studies have also shown an association between masticatory muscle function and craniofacial growth. The thickness of the masseter muscle was found to be related to the facial morphology.[6] In adults, correlations have been found between facial dimensions and jaw-muscle cross-sectional area, and between facial dimensions and masseter

craniofacial skeleton has been recognized widely as important factor in the control of craniofacial growth.[8]

Masticatory muscle function correlates with morphological features of craniomandibular to which they are geometrically related. The significance of these masticatory muscles in relation to the occlusal plane has been evaluated in terms of a possible effect upon the biomechanical characteristics of muscular forces

directed upon the dentition.[9] It is generally accepted that alveolar bone architecture and shape are maintained by stimuli through the musculature and teeth and that remodeling of bone is caused by changes in the stimuli acting on the bone.[10]

Patients with functional malocclusions were not taken into consideration, since the dimension of their masseter muscles might deviate from those of normal subjects. Malocclusions with crossbite are excluded, because masseter muscle has been found to be thinner on the functional crossbite side than on the normal side. In patients suffering from myotonic dystrophy, a decreased width of the palate has been reported. This might be due to muscle weakness. Maxillary intermolar width increases significantly in both sexes between 3 and 13 years of age, after which it remains stable in males, whereas it decreases slightly in females. In the present study as for the age period examined (18 to 25 years), intermolar width remained stable.[4]

One of the factors influencing maxillary arch width is the growth potential of the midpalatal suture. Experimental studies conducted in rats showed that the bone apposition rate in the midpalatal suture to be smaller with decreased functional demands, thereby their maxillary arch is narrower. Also the greater arch width found in medieval dentitions compared with those from a modern control sample is considered to be due mainly to differences in diet and masticatory function. Besides sutural growth, differences in the transverse width of the alveolar process or in the buccopalatal inclination of the posterior teeth might also contribute to differences in maxillary dental arch width.[4]

Masseter muscle thickness has been measured by various imaging techniques including ultrasound scanning, Computerized Tomography (CT) and magnetic resonance imaging (MRI). Computerized Tomography was used by Weijs and Hillen to measure masticatory muscle thickness in adults. The imaging technique used in that study produced reliable data but, for ethical reasons, radiographic exposure for experimental purposes is now restricted. Ultrasonography has been used in recent years in different areas of medicine. It is proven to be a reproducible, simple and inexpensive procedure, provided the operator adheres to a strict imaging protocol.[1]

Ultrasonography used to measure the thickness of the masseter muscle was found to be a reliable method, with results highly comparable to those obtained with Magnetic Resonance Image. Raadsheer et al compared both Ultrasound and MRI in the measurement of mid-belly masseter muscle thickness and showed Ultrasound to be an accurate and reproducible imaging technique.[11] However, Ultrasound imaging also allowed us to detect pathological changes in the muscle on the basis of increased echo intensity.[12]

Till now, and despite extensive studies, there is no conclusive evidence of adverse biological effects of use of ultrasound energy at diagnostic power levels[6]. Under this reason, ultrasound imaging was used in this study to measure the masseter muscle thickness.

In the literature, measurement of relaxed muscle thickness has been considered less accurate, owing to the higher susceptibility to the pressure with which the probe is placed on the cheek. In the present study, during muscle relaxation, the subjects were asked to maintain light interocclusal contacts; whereas to achieve muscle contraction, the subject was asked to clench maximally in the intercuspal position. It is possible that this position does not always coincide with maximal muscle contraction, and therefore may not be indicative of the true contraction potential of the muscles. Although the relaxed and contracted conditions under which the measurements were made were based on subjective criteria and were

difficult to control, the reliability coefficients of the repeated measurements were high. This may, however, be related to the short interval (5 minutes) between the repeated measurements. Another factor which may influence the recordings is tissue compression. So to avoid tissue compression, generous amount of gel was used under the probe. Care was taken to orientate the transducer perpendicular to the ramus, since oblique scanning exaggerates the thickness of the muscle. For that purpose, the angle of scanning was altered until the best echo of the mandibular ramus was achieved. The measurement site was at the occlusal plane, halfway between the zygomatic arch and gonial angle, approximately at the centre of the mediolateral distance of the ramus.[1]

The thickness of masticatory muscles has not received much attention, when compared with volumes of studies done on skeletal growth of the face. This can be explained by the fact that until recently, the growth of masticatory muscle and its inherent structure could be studied only by indirect means, such as recording of bite force or by examination of muscle biopsies and autopsies in cross-sectional studies. [6]

Conclusion

Masseter muscle thickness increases the sagittal growth, while limiting the vertical growth of the jaws. It tends to grow the face in a more horizontal pattern. Although jaw musculature has been cited as the possible etiological factor in the development of malocclusion and in relapse after orthodontic therapy, multivariate studies designed to correlate changes in jaw muscle thickness to intermolar have not been done much earlier.

So the findings of the study suggest that the functional capacity of the masticatory muscles should be considered as one of the factors influencing the width of the maxillary dental arch.

References:

1. Satiroğlu F, Arun T, Işik F. Comparative data on facial morphology and muscle thickness. Eur J Orthod 2005; 27(6): 562-7. Epub 2005 Aug 31.
2. Charalampidou M, Kjellberg H, Georgiakaki I, Kiliaridis S. Masseter muscle thickness and mechanical advantage in relation to vertical craniofacial morphology in children; Acta Odontol Scand 2008; 66(1): 23-30.
3. Benington PC, Gardener JE, Hunt NP. Masseter muscle volume measured using ultrasonography and its relationship with facial morphology. Eur J Orthod 1999; 21(6): 659-70.
4. Kiliaridis S, Georgiakaki I, Katsaros C. Masseter muscle thickness and maxillary dentalarchwidth. Eur J Orthod 2003; 25(3): 259-63.
5. Ueda HM, Ishizuka Y, Miyamoto K, Morimoto N, Tanne K. Relationship between masticatory muscle activity and vertical craniofacial morphology;Angle Orthod 1998; 68(3): 233-8.
6. Kiliaridis S, Kalebo P. Masseter muscle thickness measured by ultrasonography and its relation to facial morphology. J Dent Res 1991; 70(9): 1262-5.
7. Kubota M, Nakano H, Sanjo I, Satoh K, Sanjo T, Kamegai T, Ishikawa F. Maxillofacial morphology and masseter muscle thickness in adults. Eur J Orthod 1998; 20(5): 535-42.
8. Kasai K, Richards LC, Kanazawa E, Ozaki T, Iwasawa T. Relationship between attachment of the superficial masseter muscle and craniofacial morphology in dentate and edentulous humans. J Dent Res 1994; 73(6): 1142-9.

9. Prabhu NT, Munshi AK. Measurement of masseter and temporalis muscle thickness using ultrasonographic technique. J Clin Pediatr Dent 1994 Fall; 19(1): 41-4.
10. Vargervik K. Morphologic evidence of muscle influence on dental arch width. Am J Orthod 1979; 76(1): 21-8.
11. Benington PC, Gardener JE, Hunt NP. Masseter muscle volume measured using ultrasonography and its relationship with facial morphology.Eur J Orthod 1999; 21(6): 659-70.
12. Kiliaridis S, Engvall M, Tzakis MG. Ultrasound imaging of the masseter muscle in myotonic dystrophy patients. J Oral Rehabil 1995; 22(8): 619-25.