

# Comparative study between various growth pattern of masseter muscles using ultrasound imaging system

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## Abstract

**Introduction:** Among the masticatory muscle, masseter has been shown to have significant relation with bite force magnitude and craniofacial morphology. In adults, correlation has been found between facial dimension and masseter muscle thickness. Based on cephalometric values the dentofacial growth pattern has been divided into three namely, average, vertical and horizontal. To determine the pattern of relation of the facial skeleton and muscles the structure of the facial muscles ought to be investigated thoroughly in order to paint an accurate portrait of facial morphology. **Aims and objectives:** To compare between various growth pattern of masseter muscles using ultrasound imaging system. **Materials and Method:** The study consisted of 75 subjects undergoing orthodontic treatment in the Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Sciences, Sri Ramachandra University. All the subjects were divided in three groups (viz. average, vertical and horizontal growth group) containing 25 patients each. Ultrasonography was used to calculate the thickness of masseter muscle. The thickness was measured in relaxed and contracted state on both sides. **Results:** It was observed that the mean thickness of masseter in average growth group was more as compared to vertical growth group and the difference was also statistically significant. When the thickness of masseter was compared between average growth group and horizontal growth group, it was observe that thickness in average group was more as compared to horizontal group. And the difference was also statistically significant. The mean thickness of masseter muscle in horizontal growth group was more as compared to vertical growth group and the difference was highly significant. **Conclusion:** The thickness of the masseter muscle was greatest in horizontal growth pattern, followed by average growth pattern and vertical growth pattern.

**Keywords:** Masseter muscle, cephalometric values, thickness.

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## INTRODUCTION

Under the principles of Wolff's law a relationship has been defined between bone shape and muscle function<sup>1,2</sup>.

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<sup>3</sup> Among the masticatory muscle, masseter has been shown to have significant relation with bite force magnitude and craniofacial morphology.<sup>4</sup> In adults correlation have been found between facial dimension and masseter muscle thickness.<sup>4,5</sup> Based on cephalometric values the dentofacial growth pattern has been divided into three namely, average, vertical and horizontal. The major characteristic features of vertical growth pattern are increased mandibular plane angle, dolichocephalic head

form, leptoprosopic facial form, large gonial angle, short ramus, small coronoid process, antegonial notching, long anterior facial height, short posterior facial height, long lower facial height relative to upper face height, large cranial base, and downward and backward position of mandible<sup>6</sup>. Features of horizontal growth pattern include decreased mandibular plane angle, broad brachicephalic head form, euryprosopic facial form, prominent cheek bones, bulbous forehead, less prominent glabella, small gonial angle, broad and long ramus, large coronoid process, no antegonial notching on the lower border of mandible, anterior facial height equals posterior facial height, and compared with upper facial height lower face height is small<sup>6</sup>. To determine the pattern of relation of the facial skeleton and muscles the structure of the facial muscles ought to be investigated thoroughly in order to paint an accurate portrait of facial morphology. Thus the present study was undertaken to examine the variation and effects of masseter muscle thickness on vertical, horizontal and average growth patterns.

**AIMS AND OBJECTIVES**

To compare between various growth pattern of masseter muscles using ultrasound imaging system.

**MATERIALS AND METHOD**

The present study was in the Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Sciences, Sri Ramachandra University. Total 75 patients were selected for the study. The patients were divided into three groups, of 25 subjects each, based on their growth pattern.

**Group 1:** Average growth pattern (25 subjects)

**Group 2:** Vertical growth pattern (25 subjects)

**Group 3:** Horizontal growth pattern (25 subjects)

The selected patients were more than 20 years of age and were without any dental prosthesis and without any history of diseases involving the neuromuscular mechanism. The growth pattern of the patients was evaluated using lateral cephalograms of the patients taken for routine diagnosis prior to orthodontic treatment. Seven angular measurements and four linear measurements were analyzed. The thickness of masseter muscles was measured bilaterally using a GE LOGIQ P5 machine in the Department of Radiology and Imaging Sciences. A 12 MHz high- resolution linear array transducer was used, oriented perpendicular to the ramus, so as to avoid a distorted image of the muscle thickness. The angle of the transducer was altered until the best echo of the mandibular ramus surface was achieved. The site of measurement was in the thickest part of the masseter, close to the level of the occlusal plane, approximately in the middle of the mediolateral distance of the ramus. The imaging and the measurement were made bilaterally with the subjects seated upright, with the head in postural rest position. The variation in thickness in both relaxed and contracted states was measured. The measurements were made directly on the screen. The imaging and measurements are performed three times, with an interval of at least five minutes between the scanning and the thickness per side was calculated as the average of the three measurements. The relationship between the muscle thickness with growth pattern, anterior and posterior facial heights are then compared.

**RESULTS**

**Table 1:** Comparison of masseter thickness in average and vertical growth group

Muscle group		N	Mean	Std. Deviation	Std. Error Mean	P value (2 tailed)	Mean Difference
Right masseter relaxed	Average	25	10.476	1.7227	0.3445	0.009	1.2000
	Vertical	25	9.276	1.3621	0.2724		
Right masseter contracted	Average	25	11.468	1.7095	0.3419	0.013	1.1320
	Vertical	25	10.336	1.3732	0.2746		
Left masseter relaxed	Average	25	10.49	1.377	0.275	0.005	1.144
	Vertical	25	9.34	1.339	0.268		
Left masseter contracted	Average	25	11.412	1.2558	0.2512	0.021	0.8760
	Vertical	25	10.536	1.3363	0.2673		

It was observed that the mean thickness of masseter in average growth group was more as compared to vertical

growth group and the difference was also statistically significant.

**Table 2:** Comparison of masseter thickness in average and horizontal growth group

Muscle group		N	Mean	Std. Deviation	Std. Error Mean	P value (2tailed)	Mean Difference
Right masseter relaxed	Average	25	10.476	1.7227	0.3445	0.004	-1.3520
	Horizontal	25	11.828	1.3761	0.2752		
Right masseter contracted	Average	25	11.468	1.7095	0.3419	0.003	-1.4080

Left masseter relaxed	Horizontal	25	12.876	1.4825	0.2965	0.002	-1.372
	Average	25	10.49	1.377	0.275		
Left masseter contracted	Horizontal	25	11.86	1.611	0.322	0.001	-1.4200
	Average	25	11.412	1.2558	0.2512		
	Horizontal	25	12.832	1.6339	0.3268		

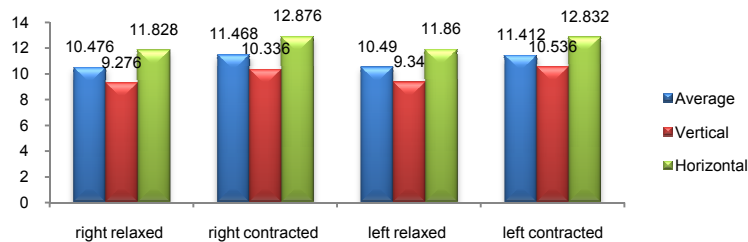
When the thickness of masseter was compared between average growth group and horizontal growth group, it was observe that thickness in average group was more as

compared to horizontal group. and the difference was also statistically significant.

**Table 3:** Comparison of masseter thickness in vertical and horizontal growth group

Muscle group		N	Mean	Std. Deviation	Std. Error Mean	P value(2 tailed)	Mean Difference
Right masseter relaxed	Vertical	25	9.276	1.3621	0.2724	0.000	-2.5520
	Horizontal	25	11.828	1.3761	0.2752		
Right masseter contracted	Vertical	25	10.336	1.3732	0.2746	0.000	-2.5400
	Horizontal	25	12.876	1.4825	0.2965		
Left masseter relaxed	Vertical	25	9.34	1.339	0.268	0.000	-2.516
	Horizontal	25	11.86	1.611	0.322		
Left masseter contracted	Vertical	25	10.536	1.3363	0.2673	0.000	-2.2960
	Horizontal	25	12.832	1.6339	0.3268		

The mean thickness of masseter muscle in horizontal growth group was more as compared to vertical growth group and the difference was highly significant.



**Figure 1:** Comparison of masseter muscle thickness between average, horizontal and vertical growth group.

**DISCUSSION**

The present study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, Faculty of Dental Sciences, Sri Ramachandra University with the objective to compare between various growth patterns of masseter muscles using ultrasound imaging system. For the purpose of study patients more than 20 years were selected. Because earlier studies have indicated that there will not be any variation in muscle thickness and stature after the age of 20 years.<sup>7</sup> Various highly sophisticated imaging techniques like computed tomography (CT), cone beam computed tomography (CBCT), magnetic resonance imaging (MRI), ultrasound etc are being used in the field of orthodontics. But in Computed tomography and cone beam computed tomography use of ionizing radiation is done and so they are disadvantageous. Magnetic resonance imaging is time consuming and is expensive. Thus among these techniques, ultrasonography is advantageous because it has no known cumulative biological effects. The efficiency of ultrasonography as an instrument for measuring muscle thickness has been

proved in previous studies<sup>7,8,9,10</sup>. It is accurate, reliable and an inexpensive technique. Thus in the present study ultrasound was used for the measuring the muscle thickness. When the thickness of masseter is measured variation was observed in all the three groups. The thickness of right masseter muscle in relaxed state, in average (mean = 10.47mm), vertical (mean = 9.27mm) and horizontal (mean = 11.82mm) growth patterns showed that masseter muscle is thicker in horizontal growth pattern compared to average and vertical growth patterns. Contracted state also showed the same pattern of thickness (average = 11.46mm; vertical = 10.33mm and horizontal = 12.87mm). Similar results were observed in both relaxed (average = 10.49mm; vertical = 9.34mm; horizontal = 10.56mm) and contracted (average = 11.41mm; vertical = 10.53mm; horizontal = 12.83mm) states for the left masseter muscle. All values of masseter muscle in both relaxed and contracted state showed a statistically significant variation (P=.000) in thickness between average, vertical and horizontal growth patterns. The results of the present study showed that there was a

significant variation in masticatory muscle thickness among average, vertical and horizontal growth patterns. Right and left sides did not show much variation in muscle thickness. Inter-individual differences in the cross-section of the masseter muscle may be due to a variable number of muscle fibres, variation in fibre size, or both<sup>11</sup>. A strong correlation was found between growth pattern, and masseter muscle thickness, indicating that individuals with a thin masseter have a vertical growth pattern. The results were similar to previous studies done by, Satiroglu *et al*<sup>2</sup>, Raadsheer *et al*<sup>7</sup>, Kiliaridis and Kalebo<sup>11</sup> and Benington *et al*<sup>12</sup>, etc. who observed a strong correlation between masseter muscle thickness and facial morphology.

## CONCLUSION

The thickness of the masseter muscle was greatest in horizontal growth pattern, followed by average growth pattern and vertical growth pattern.

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