MASSETER ACTIVITY,
ARCH WIDTH AND FACIAL TYPE

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Abstract:
The present study investigated the effect of masseter muscle thickness on maxillary dental arch width and growth pattern of face. Sample comprised of 40 patients, (20 females, 20 males) between 18 to 23 years. They were subdivided according to molar relation (10 Class I, 10 Class II). Masseter muscle thickness was measured by Ultrasonography. Maxillary dental arch width was measured on dental casts, using calipers, between the palatal surfaces of first permanent molars. The growth pattern of face was assessed by lateral cephalograms. Results: The masseter muscle thickness was more in males and Class II groups compared to females and Class I groups respectively. In all the subgroups masseter muscle thickness had a positive linear correlation with maxillary dental arch width, midfacial length and corpus length (r = 0.5) and a negative linear correlation with ramal height, mandibular ratio and sum of angles (r = -0.7). Conclusions: An increase in masseter muscle thickness widens the maxillary dental arch. Masseter muscle increases the sagittal growth, while limiting the vertical growth of jaws. It tends to make the face grow in a more horizontal pattern.

INTRODUCTION:
It is widely accepted that an interaction exists between masticatory muscle function and craniofacial growth. Studies have shown an association between the functional capacity of the masticatory muscles and craniofacial morphology. Individuals with a short facial configuration have high electromyographic activity/bite force or vice versa. Masticatory muscle function was found to influence the transverse growth of the skull at areas under direct muscle influence. Muscle thickness had a significantly negative relation with anterior facial height and mandibular length, and a significantly positive relation with intergonial width and bizygomatic facial width. Among the masticatory muscles, masseter has been shown to have significant relation with bite force magnitude and craniofacial morphology. In adults, correlations have been found between facial dimensions and masseter muscle thickness. Since there is an association between masseter muscle thickness and craniofacial width, a similar association might be expected to exist regarding dental arch width, particularly in regions with molars under eruption. Maxillary intermolar width showed a direct, significant association with masseter thickness both during contraction and relaxation, i.e. individuals with thicker masseter muscles had a wider maxillary dental arch.
Furthermore, an increase in the function of the masticatory muscles is associated with anterior growth rotation pattern of the mandible and with well-developed angular, coronoid, and condylar processes.  

Studies have shown a connection between masseter thickness and function of the muscle. Muscle thickness was correlated to bite force and facial dimensions. So muscle thickness can be used as a measure muscle activity instead of electromyography.

The present study investigated the role of masseter in the craniofacial growth and maxillary dental arch width. Masseter muscle thickness was used as an indicator of its activity.

MATERIALS AND METHOD

Stratified random sampling was done. 10 consecutive patients were selected for each stratum, in the age group of 18 to 23 years from the outpatients to the department of Orthodontics, Government dental college, Bangalore. The purpose and methodology of the study were explained to the subjects and written consent was obtained. The subjects were selected as to their molar relations (either Class I or Class II) and with minimal or no malocclusion in the buccal segment.

A) Measurement of masseter muscle thickness:

The masseter thickness of the right and left sides were found out through ultrasound scanning of the muscle using the Hewlett Packard 8.5 Ultrasound Scanner and Probe. The muscle thickness was measured in both relaxed and clenched states (Fig.1A&B). This scanning was repeated after 5 minutes to reduce the measuring errors. This gave a total reading of eight. Then the averages were calculated for both contracted and relaxed states.

B) Measurement of the maxillary dental arch width:

Hydrocolloid Impressions of the subjects were made and their maxillary casts obtained. Using a divider the distance between the palatal surfaces of the maxillary first molars from the greatest height of contour was measured. This gave the intermolar width in maxilla (Fig.2).

C) Measurement of the growth pattern of the face:

Standard lateral cephalograms of the subjects were obtained using a Villa machine and cephalostat. The lateral cephalograms were traced on 0.001" acetate paper, by a single operator. Linear and angular parameters were measured from the tracings (Fig.3). The parameters were remeasured for 10 randomly selected patients, to check intra-observer error. The readings were tabulated and analyzed using the SPSS statistical analysis package.

- ANOVA – for comparison between groups
- Correlation regression analysis – for association of muscle thickness to dental arch width and growth pattern
- Paired 't' test – for intraobserver error were done.

RESULTS

The masseter muscle thickness was significantly more in males, as compared to females (p<0.05). There was no significant difference in masseter muscle thickness between Class I and II groups (Table.I). Masseter muscle thickness showed a positive linear correlation with maxillary dental arch width, effective mandibular length, mid facial length and corpus length. Masseter Muscle thickness showed a negative linear correlation with Jarabak's ratio, ramal height, mandibular ratio and sum of angles (Table.II). The correlations between all the parameters were statistically significant (p<0.05), except for that between the muscle thickness and Jarabak's ratio, which was not statistically significant (p>0.05). These associations were stronger in females as compared to males.

The regression equation associating masseter muscle thickness (contracted) to the maxillary dental arch width was:

\[ \text{Maxillary dental arch width (mm)} = 19.097 + 0.958 \times \text{Masseter Muscle Thickness (mm)} \]

It had a predictability factor of 24.6%. The equation having the highest predictability factors were those associating masseter muscle thickness with mandibular ratio (67.5%), sum of angles (65.2%) and corpus length (60.8%).

DISCUSSION

Theories on bone plasticity may be traced to Wolff and Roux who believed that form and function were related intimately. Moss1,12 gave an insight into the mechanism by which the muscles affect the growth of the craniofacial skeletal structures. There is now ample evidence, implying a major role of masticatory muscles in facial growth. Large masticatory muscles are associated with brachycephalism and vice versa. Muscle thickness may be measured using Magnetic Resonance Imaging, Computed Tomography or Ultrasound. But for clinical examinations, Ultrasonography is better than MRI and Computerized...
Tomography because it is rapid, inexpensive technique, the equipment can be easily handled and transported and it has no known cumulative biological effect. Ultrasonography is an accurate and reproducible method for measuring the thickness of the masseter in vivo. It allows for large-scale longitudinal study of changes in jaw-muscle thickness during growth in relation to change in biomechanical properties of masticatory muscles.\textsuperscript{9,13,14} So ultrasonography was used to measure muscle thickness in the current study.

The findings of the present study can be discussed under the following headings:

I. The association of masseter muscle thickness to molar relationship and gender

II. The influence of masseter muscle thickness on maxillary intermolar width.

III. The influence of masseter muscle thickness on growth pattern of face.

I. The association of masseter muscle thickness to molar relationship and gender

The sample was divided into two groups, females and males (N= 20), which were further subdivided into Class I and Class II subgroups, based on their molar relation. In the present study males had thicker masseter muscle as compared to females. This is corroborated by Kiliaridis et al\textsuperscript{15}, who concluded that the mean thickness of the masseter in men was larger than that in women, and the thickness of the muscle was related to the male facial morphology. The study by Kiliaridis et al\textsuperscript{5}, also reported that normally, in adults, the males have thicker masseters than females. Masseter muscle thickness was greater in the Class II group than in Class I, but not significantly so.

II. The influence of masseter muscle thickness on maxillary intermolar width.

In the present study an increase in the muscle thickness led to a corresponding increase in the dental arch width. This is in agreement with the studies by Kiliaridis et al\textsuperscript{15} and Katsaros\textsuperscript{3} where they affirm that the functional capacity of the masticatory muscles may be considered as one of the factors influencing the width of the maxillary dental arch. They demonstrated that subjects with thicker masseter muscles had a wider maxillary dental arch.

III. The influence of masseter muscle thickness on growth pattern of face.

In this study masseter muscle increased the sagittal growth, while limiting the vertical growth of jaws. It tended to make the face grow in a more horizontal pattern. Increased masseter thickness increased the length of the body of the mandible, and the maxilla, while reducing the anterior facial height and height of the ramus. It also caused a corresponding decrease in the mandibular ratio, indicating a horizontal pattern of growth. This agrees with Kiliaridis et al\textsuperscript{15} and Benington et al\textsuperscript{6} who reported that masseter muscles were especially large in persons with brachycephalic skulls, short faces and a small jaw angle. Raadsheer et al\textsuperscript{14,11}, Ueda et al\textsuperscript{16} and Tuxen et al\textsuperscript{17} concluded from their studies that there was a strong association of masseter muscle thickness with facial type, which is in agreement with the present study.

The effect of masseter muscle thickness on the transverse growth of the jaws could not be ascertained from the current study. But in previous studies\textsuperscript{6,7} it has been hypothesized that the increased loading of the jaws due to masticatory muscle hyperfunction may lead to increased sutureal growth and bone apposition, resulting in an increased transverse growth of the maxilla and broader bone bases for the dental arches.

CONCLUSIONS

a. The masseter muscle thickness is more in males than females, but does not exhibit significant difference between Class I and Class II groups.

b. An increase in masseter thickness is accompanied by a corresponding increase in the maxillary dental arch width.

c. Increase in masseter muscle thickness causes more horizontal growth of the face and the resulting facial type will be brachyfacial.

REFERENCES


Fig.1: Ultrasound Scan of the masseter muscle in relaxed (A) and contracted (B) states. The maximal thickness of the muscle was measured digitally by the machine itself by the locating cursors (arrows).

Fig.2: Measurement of the maxillary dental arch width between the palatal surfaces of the permanent first molars, using calipers

Fig.3: Linear & angular cephalometric landmarks used to assess the growth pattern of the face

1. Effective mandibular length – Co to Gn
2. Midfacial Length – Co to ptA
3. Posterior facial height – S to Go
4. Anterior facial height – Na to Me
5. Ramal height – Ar to Go
6. Corpus length – Go to Me
7. Sum of angles – Saddle(A)+Articular(B)+Gonial(C) angles
8. Mandibular ratio – Ramal height

Corpus length

Table I: Comparison of mean values (in mm) of masseter muscle thickness, relaxed (MMTR) and contracted (MMTC) between females & males and Class I & Class II grps

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>MMTR avg</th>
<th>Std Dev</th>
<th>MMTC avg</th>
<th>Std Dev</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>20</td>
<td>8.49</td>
<td>0.77</td>
<td>11.46</td>
<td>0.91</td>
<td>0.0003</td>
</tr>
<tr>
<td>Male</td>
<td>20</td>
<td>8.65</td>
<td>1.01</td>
<td>12.54</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>Class I</td>
<td>20</td>
<td>7.95</td>
<td>0.70</td>
<td>11.91</td>
<td>0.99</td>
<td>0.5718</td>
</tr>
<tr>
<td>Class II</td>
<td>20</td>
<td>9.19</td>
<td>0.58</td>
<td>12.09</td>
<td>1.07</td>
<td></td>
</tr>
</tbody>
</table>

Table II: Correlation between masseter muscle thickness, maxillary dental arch width & the cephalometric measurements

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Correlation coefficient (r)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary dental arch width</td>
<td>40</td>
<td>30.59</td>
<td>1.97</td>
<td>0.36</td>
<td>0.028</td>
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<tr>
<td>Effective mandibular length</td>
<td>40</td>
<td>108.49</td>
<td>3.97</td>
<td>0.60</td>
<td>&lt;0.0001</td>
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<tr>
<td>Midfacial length</td>
<td>40</td>
<td>85.23</td>
<td>4.07</td>
<td>0.41</td>
<td>0.0092</td>
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<td>Jarabak's ratio</td>
<td>40</td>
<td>62.73</td>
<td>1.72</td>
<td>-0.27</td>
<td>0.0955</td>
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<tr>
<td>Ramal height</td>
<td>40</td>
<td>57.59</td>
<td>2.03</td>
<td>-0.78</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Corpus length</td>
<td>40</td>
<td>67.09</td>
<td>2.13</td>
<td>0.85</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mandibular ratio</td>
<td>40</td>
<td>85.99</td>
<td>5.36</td>
<td>-0.88</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Sum of angles</td>
<td>40</td>
<td>393.7</td>
<td>3.91</td>
<td>-0.81</td>
<td>&lt;0.0001</td>
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