The relationship of masseter muscle thickness and Body Mass Index (BMI) in children with unilateral cleft lip and palate - An ultrasonographic study

Rakesh. B. Chandrappa and Ravi. M. Subrahmanyaa*

Orthodontic Resident, Department of Orthodontics and Dentofacial Orthopaedics, A.B. Shetty Memorial Institute of Dental Sciences Mangalore, India - 575018.

*Correspondence Info:
Dr. Ravi. M. Subrahmanyaa M.D.S; M.Orth.R.C.S (Eng)
Professor
Department of Orthodontics and Dentofacial Orthopaedics,
A.B. Shetty Memorial Institute of Dental Sciences,
Nitte University, Mangalore, India-575018.
E-mail: drmsravi@gmail.com

Abstract

Background and Objectives: The masseter muscle has a major influence on the transverse growth of the mid face. It has also been shown that delay in the growth and development is the principle reason behind small size of the body or reduced Body Mass Index (BMI) in cleft patients. The aims of this study were to measure the masseter muscle thickness and BMI and to correlate the relationship in Unilateral Cleft lip and Palate (UCLP) patients.

Materials and Method: 30 children with UCLP (11 males and 19 females) and 30 non-CLP (17 males and 13 females) children in the age group of 10 to 15 years were selected. The masseter muscle thickness was measured by a real-time ultrasound imaging technique. The measurements were performed under relaxed and in contracted position. BMI was calculated using the standard formula for each individual. The data was analyzed using ANOVA and Pearson’s correlation analysis.

Results: Under relaxed conditions, the mean muscle thickness in cleft children was 8.1(±1.3) mm, and under contracted conditions it was 10.3 (± 1.5) mm. In non-cleft children the respective measurements were 8.4 (±1.6) mm and 10.5 (± 2.1) mm. The mean BMI for cleft individuals was 16.2 (± 3.0) kg/m² and for non cleft group, it was 16.0 (±1.6) kg/m².

Conclusion: UCLP children have decreased masseter muscle thickness and an increased BMI but the differences were not statistically significant when compared to non-cleft individuals. Masseter muscle thickness in contracted condition was found to be significantly correlated to BMI in UCLP individuals.

Keywords: BMI, Cleft lip and Palate, Masseter muscle, Ultra-sonography

1. Introduction

Cleft Lip and Palate (CLP) is the most prevalent congenital defect of Dentofacial development. The principle goal of the treatment is to establish good function, which in turn will permit optimal subsequent growth and development in cleft children. It has been shown that delay in the growth and development is the principle reason behind small size of the body or reduced Body Mass Index (BMI) in cleft patients. BMI is defined as the individual’s body weight in kilograms divided by the square of his height in meters. The formula used in medicine produces a unit of measure of kg/m². Muscle thickness has been considered as one of the indicator of jaw muscle function and is significantly correlated with maxillofacial morphology. The masticatory muscles are important in elevating the mandible during food intake, facial expression, swallowing of saliva and precise articulatory movements while speaking. The activities of the muscles of mastication influence the growth of jaw bones. The masseter muscle is shown to have the major influence on the transverse growth of the midface and vertical growth of the mandible. The thickness of the masseter muscle during relaxation and contraction was found to be significantly correlated with BMI in non-CLP individuals. There are no studies available on the influence of BMI on masseter muscle in cleft patients. Hence this study is designed and carried out with aims of measuring the thickness of masseter muscle and BMI in UCLP (UCLP) patients and to compare them with that of non cleft individuals.

2. Material and Methods

30 UCLP (19 females and 11 males) and 30 non-cleft children (17 females and 13 males) in the age group of 10-15 years were selected for the study.

- Group I (Study group) – 30 UCLP children.
- Group II (Control group) – 30 non-cleft children with skeletal class I relation, near normal Dental occlusion with Angle’s class I molar relation, normal Overjet and overbite, midline coinciding with no facial asymmetry. Selection criteria were based on examination of the subjects’ lateral cephalograms and clinical examinations.

2.1 Exclusion Criteria for Group I:
- Children with Bilateral cleft lip and palate
- Patients with only cleft lip
- Skeletal and Muscular disorders
- Cleft associated with syndromes
- Patients not willing to participate in the study

2.2 Exclusion Criteria for Group II:
- History of previous orthodontic /cosmetic surgical treatment
- Presence of moderate to severe malocclusion
- Missing teeth
- Individuals not willing to participate in the study
Chandrappa and Subrahmanya

Written informed consent was obtained from each subject / parents. Lateral cephalograms were made for non-cleft children, using Planmecca PM 2002 cc Prolene radiographic machine (Planmecca, Helsenki, Finland), under standard conditions. All the cephalograms were traced by same person using 0.5mm lead pencil onto a sheet of cellulose acetate paper over tracing table. 2angular (Sella- Nasion-Point A, Sella- Nasion-Point B) and 2 linear (Nasion ┴ Point A, Nasion ┴ Point B) measurements were made up to an accuracy of 0.5° and 1mm respectively in order to define the skeletal class I individuals. Selected children were subjected to ultrasonography procedure.

2.3 Measurement of Masseter muscle thickness

All ultrasonographs were obtained using a LOGIQ 400 PROSERIES scanner using multi frequency 7.5 – 11.0 MHZ broad band transducer. A water based gel was applied to the probe before the imaging procedure. During imaging the transducer was held perpendicular to the surface of the skin and care was taken to avoid excessive pressure. The measurement was made at the thickest part of the masseter close to the level of occlusal plane, approximately in the middle of the medio-lateral distance of ramsus. The imaging and measurements were performed bilaterally under two different conditions, when the teeth are occluding gently with muscle in relaxed position (Figure1) and during maximal clenching, with the masseter muscle contracted (Figure2).The measurements were made directly from the image at the time of scanning.

![Fig 1: Ultrasonographic image of relaxed Masseter muscle in UCLP](image1)
![Fig 2: Ultrasonographic image of contracted Masseter muscle in UCLP](image2)

2.4 Measurement of BMI

The subject’s body height in meters and weight in kilograms were measured. BMI was calculated using the formula, BMI = Wt/ Ht²

2.5 Statistical method

Data obtained were evaluated using Analysis of Variance (ANOVA) and Pearson’s Correlation analysis (r).

\[ r = \frac{\sum xy - \frac{1}{N} \sum x \sum y}{\sqrt{\left(\sum x^2 - \frac{1}{N} (\sum x)^2 \right) \left(\sum y^2 - \frac{1}{N} (\sum y)^2 \right)}} \]

Where, \( x \) = body mass index, \( y \) = muscle thickness

3. Results

In both the groups, there were no significant difference between males and females in the values of muscle thickness as well as that of BMI and hence comparisons were carried out only between the groups as a whole.

3.1 Comparison of masseter muscle thickness between two groups

The mean masseter muscle thickness in Group I was 8.1483±1.39664 mm and 10.3683±1.58847 mm in relaxed and contracted states respectively. The mean masseter thickness in Group II was 8.4166±1.66007 mm and 10.5500±2.13251 mm in relaxed and contracted states respectively. There was no statistically significant difference in both relaxed and contracted states between the groups.(Table 1)

<table>
<thead>
<tr>
<th>Muscle state</th>
<th>Group</th>
<th>Mean</th>
<th>S. D</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relaxed</td>
<td>I</td>
<td>8.17</td>
<td>1.28</td>
<td>0.61</td>
</tr>
<tr>
<td>Right side</td>
<td>II</td>
<td>8.36</td>
<td>1.63</td>
<td>0.50</td>
</tr>
<tr>
<td>Relaxed</td>
<td>I</td>
<td>8.12</td>
<td>1.50</td>
<td>0.40</td>
</tr>
<tr>
<td>Left side</td>
<td>II</td>
<td>8.47</td>
<td>1.68</td>
<td>0.83</td>
</tr>
<tr>
<td>Contracted</td>
<td>I</td>
<td>10.42</td>
<td>1.48</td>
<td>0.70</td>
</tr>
<tr>
<td>Right side</td>
<td>II</td>
<td>10.60</td>
<td>2.01</td>
<td>0.38</td>
</tr>
<tr>
<td>Contracted</td>
<td>I</td>
<td>10.31</td>
<td>1.69</td>
<td>0.71</td>
</tr>
<tr>
<td>Left side</td>
<td>II</td>
<td>10.49</td>
<td>2.24</td>
<td>0.36</td>
</tr>
</tbody>
</table>

3.2 Comparison of BMI between two groups

The mean body mass index for Group I was 16.2288±3.08765 kg/m² and for Group II, it was 16.0895±1.61561 kg/m². There was no statistically significant difference between the groups. (Table2)

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>S. D</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>30</td>
<td>16.22</td>
<td>3.08</td>
<td>0.82</td>
</tr>
<tr>
<td>II</td>
<td>30</td>
<td>16.08</td>
<td>1.61</td>
<td>0.21</td>
</tr>
</tbody>
</table>
3.3 Pearson’s Correlation between masseter muscle thickness and BMI in Group I

Pearson’s Correlation analysis in Group I revealed that there was a significant correlation between masseter muscle thickness in contracted state and BMI (p=0.038). There was no significant correlation between masseter muscle thickness in relaxed state and BMI (p=0.814), (Table 3)

<table>
<thead>
<tr>
<th>Group</th>
<th>Muscle state</th>
<th>r</th>
<th>P value</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Relaxed</td>
<td>0.045</td>
<td>0.814</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Contracted</td>
<td>0.381</td>
<td>0.038*</td>
<td>30</td>
</tr>
</tbody>
</table>

*Significant P < .05.

3.4 Pearson’s Correlation between masseter muscle thickness and BMI in Group II

Pearson Correlation analysis in Group II revealed that there was no significant correlation between masseter muscle thickness (both in relaxed and contracted state) and BMI (p=0.597, 0.484), (Table 4)

<table>
<thead>
<tr>
<th>Group</th>
<th>Muscle state</th>
<th>r</th>
<th>P value</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Relaxed</td>
<td>0.100</td>
<td>0.597</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Contracted</td>
<td>0.133</td>
<td>0.484</td>
<td>30</td>
</tr>
</tbody>
</table>

4. Discussion

The growth of jaw bones is mainly influenced by the activities of the muscles of mastication, out of which the masseter is said to have the major influence. Masseter thickness has been considered as one of the indicator of jaw muscle function and is significantly correlated with maxillofacial morphology. Influence of masseter muscle on surrounding bones in various skeletal jaw relationships has been studied. Ultrasonographic studies of circumoral musculature in Cleft patients have been done in the past. The review of literature yielded in no study for ultrasonographic evaluation of masseter muscle thickness in UCLP patients.

Electromyographic study has revealed the masticatory dysfunction in patients with UCLP when compared with the normal occlusion group. In another study, it was demonstrated that the cleft individuals had lower potential function of masseter and temporalis, inharmonious activity of the masticatory muscles during mandibular border movement, a higher asymmetry index of the masseter and temporalis muscles, and the longer silent periods of the two muscles. The function of masticatory muscles is different in patients with UCLP with anterior cross bite. The investigators concluded that the muscle function should be considered when evaluating cleft patients for orthodontic treatment and orthognathic surgery.

The anomalies of the soft tissues in the cleft patients include the abnormal insertion of muscles and subsequent underdevelopment of the premaxilla and the alveolus. The skeletal anomalies result mainly due to abnormal insertion and function of peri-oral muscles, and the non-functional repair of the cleft lip and alveolus (with or without cleft palate). The skeletal anomalies would almost regress by achieving a correct morpho-functional reconstruction of muscles.

The present study was conducted with the aims of measuring the masseter muscle thickness and BMI in UCLP patients in order to correlate the relationship between BMI and masseter muscle thickness. 30 children with UCLP (19 females and 11 males) and 30 children without cleft (17 females and 13 males) were included. The masseter muscle thickness was measured bilaterally by a real-time ultrasound imaging technique. Ultrasonography has been used in recent years in different areas of medicine. It has several advantages over CT and MRI. In contrast to CT, ultrasonography has no known cumulative biological effects. It is proven to be reproducible, simple and inexpensive method for accurately measuring muscle thickness. BMI was calculated using the standard formula using the body weight and height.

The data was analyzed using ANOVA and Pearson’s correlation analysis. The results of present study revealed a decreased masseter muscle thickness in both relaxed and contracted state and an increased BMI in UCLP children when compared to non cleft children. The masseter muscle thickness in contracted condition was found to be significantly related to BMI in cleft individuals.

Our study showed statistically no significant difference in BMI between cleft and non cleft groups though the cleft children had higher BMI index. This is in contrary to the study that showed shown that children born to 10 years of age with isolated CL, CP, or CLP have a mean height below the population mean and children with isolated cleft manifest an intrinsic tendency toward short stature. However studies have also shown that the body dimensions of infants with isolated cleft lip were not different from those of control subjects, but infants with isolated cleft palate or cleft lip and palate were found to be lighter and shorter than control subjects, but these differences were not statistically significant. Feeding difficulties early in life is a primary contributory factor for the difference in the body mass index. Patients with isolated clefts do not have a deficit with regard to their body mass index during childhood and adolescence relative to the general population. The reasons for this are multi-factorial and the growth difficulties experienced by cleft patients early in life do not persist into later ages.

The present study showed UCLP patients had a significant correlation between masseter muscle thickness in contracted state and BMI. Significant correlations were also found between the masseter muscle thickness and different facial morphologies. Correlations were also noted between muscle thickness and BMI in vertical facial pattern.

Although we cannot draw absolute conclusions, our results do provide necessary preliminary conclusions for a potentially larger prospective study of body mass indexes among patients with clefts throughout childhood and adolescence. Further studies in different types of clefts in different ethnic groups are required for confirmative conclusions.

5. Conclusion

The following conclusions can be drawn from the present study:

1. Masseter muscle is thinner in children with UCLP but the difference is not statistically significant.
2. BMI is less in children with UCLP but the difference is not statistically significant.
3. There is a significant correlation between the thickness of contracted masseter muscle and BMI in children with UCLP.

Acknowledgement

We thank Dr. Shri Krishna, Professor and Head, Department of Radiology, Nitte University and Prof. Krishna Nayak U.S, Head, Department of Orthodontics, Nitte University for their support for the study.
References

3. Peter A. Duncan; Lawrence R. Shapiro; Robert L. Soley; Stanley E. Turet. Linear Growth Patterns in Patients With Cleft Lip or Palate or Both. Am J Dis Child. 1983; 137(2):159-163.