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An Evaluation of Masseter Muscle Anatomy in Different Facial Patterns Using Magnetic Resonance Imaging: A Comparative Study

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ABSTRACT

Aim: To study the anatomical variations of masseter muscle in subjects with different facial patterns using MRI as well as assessing the correlation between them.

Methodology: A total of 30 young, healthy subjects in the age group of 20-28 years were selected and divided into 3 groups of 10 each as vertical, average and horizontal growers using lateral cephalograms. In these subjects, various anatomic dimensions of masseter muscle were measured using MRI, in sagittal, axial and coronal views.

Results: The results showed a statistically significant difference between the vertical and horizontal growth patterns ($p<0.05$), with respect to Masseter muscle distance from anterior and posterior fibres distal to the 1st molar and orientation of the muscle fibres to the zygomatic arch.

Conclusion: In our study, we noticed that the orientation of muscle fibres is directed more posteriorly and at a more acute angle whereas in horizontal group the fibres are vertically oriented with anterior attachment at the angle of the mandible.

Keywords Masseter muscle, Growth patterns, MRI.

INTRODUCTION

The role of jaw muscle function as a determinant of the growth and development of the human craniofacial complex has been studied extensively. In particular, the relationship between excessively vertical growth patterns of the skull (long-face morphology) and abnormal jaw muscle function has received considerable attention. However, none of these studies could give any information as to whether jaw muscle function determines the outcome of craniofacial growth or whether growth affects jaw muscle function. Only experimental studies of the effect of induced abnormal muscle function on skull growth can answer this question. If jaw muscle function influences craniofacial growth, it is likely that this influence is mediated not only via the magnitude of muscle force but also by the spatial orientation of the force vector. [1-6]Other contributing factors, such as the intrinsic muscular properties, and the degree and mode of activation, are not taken into account in this study. It

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is obvious that the direction of the muscle forces determines the evoked stress patterns in the growing bones and cartilages, and that these stress patterns directly influence the growth process.[7] Experimental studies in which the orientation of the jaw muscles of juvenile dogs [8] and monkeys [9] has been altered surgically yielded conflicting results. Only Hohl observed a significant increase in vertical skull growth after reinserting the temporalis and masseter muscles in a more oblique direction, limiting the biomechanical efficiency of these muscles. So far, data of correlational studies describing the relationships between jaw muscle orientation and human craniofacial morphology are scarce and are obtained predominantly by means of cephalometric techniques.[10,11] These studies indicated that subjects with a long-face morphology have relatively oblique orientated jaw muscles relative to the nasion-sella line, as well as to the Frankfort horizontal plane (FH).The reduced efficiency of the jaw closing muscles has been speculatively associated with the aetiology of long-face morphology. Sassouni et al., postulated the concept of a posterior vertical chain of muscles, consisting of the temporalis, masseter and medial pterygoid muscles, controlling the vertical skull growth. It was believed that in long-face subjects this muscle chain was obliquely orientated and situated posteriorly with respect to the temporomandibular joint. [12.13]The availability of non-invasive imaging techniques such as computer tomography (CT) and magnetic resonance imaging (MRI) has considerably facilitated in vivo studies of the human jaw muscles. In recent studies, serial MRI scans have been used for in vivo assessment of the orientation of human jaw muscles.[14]

AIM OF THE STUDY

To study the anatomical variations of masseter muscle in subjects with different facial patterns using MRI as well as assessing the correlation between them.

METHODOLOGY

Thirty subjects willing to undergo orthodontic treatment at the Department of Orthodontics and Dentofacial Orthopedics, GITAM Dental College &Hospital, Visakhapatnam, A.P, India were included in this study. A written consent was obtained from all the participants prior to conducting the study. They were all post-adolescent with a mean age group of 20-28 years and were included in three different groups with 10 samples each. Lateral cephalograms were taken for all the selected subjects. People with systemic diseases, as well as with any orthognathic surgical history were excluded from the present study.

Group 1-Vertical growth pattern

Group 2-Average growth pattern

Group 3- Horizontal growth pattern

Tracing of the cephalogram was done on an acetate paper and analysis of four angular and one proportional variable to define the growth pattern of the subject was done.

The following measurements were made on image produced by MRI scan.

1. Distance between the anterior fibers to the distal aspect of 1st molar
2. Distance between the posterior fibers to the distal aspect of 1st molar
3. Orientation of the muscle fibers.

Distance between Fibres and 1st molar: This is the distance between the distal aspect of the 1st molar to the anterior part and posterior part of the muscle fibres seen in the axial view.

Orientation of the fibres: This is the posterior angle formed between the reference line connecting the inferior border of the zygoma to the external auditory meatus and the line drawn parallel to the mid-fibres in sagittal view.

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All the obtained values were tabulated and statistically analysed. The measurements of the different parameters were calculated as the mean and Standard Deviation using ANOVA one-way test to find the significant value within the groups. Post Hoc Tukey HSD test was performed to find the significant values ($p<0.05$) between the groups

RESULTS

The mean values of the distance between the anterior fibres distal to the first molar in the vertical (17.30±1.64mm), horizontal (13.30±2.00mm) and average (14.60±1.96mm) groups. At 95% confidence level, a Post Hoc Tukey HSD (Honest Significant Difference) test for multiple comparisons among the three study groups for the distance between the anterior fibres distal to the first molar shows that, there is a statistically significant difference when the vertical group is compared with the horizontal and average groups. However there was no statistically significant difference when the horizontal and average groups are compared with each other. (Table 1)

The comparison of the mean distance of the posterior fibres distal to the 1st molar in the vertical (52.70±1.64mm), horizontal (57.60±1.71mm) and average group (56.60±1.71mm). Post Hoc Tukey HSD (Honest Significant Difference) test for multiple comparisons among the three study groups showed that, there was a statistically significant difference when the vertical group is compared with the horizontal and average group respectively. However, there is no statistically significant difference when the average and horizontal groups are compared with each other. (Table 2) The mean angulation of fibres of the masseter in vertical group (64.600±2.20), horizontal group (72.700±1.490) & average group (68.000±1.760). there was statistically significant difference when the vertical group is compared with both average and horizontal groups with the mean difference of 3.400 and 8.100. Also, there was a statistically significant difference when the horizontal and average groups are compared with each other with a significant difference of 4.700. (Table 3)

Table 1- Statistical measurements assessing the Distance between the anterior fibres of masseter muscle distal to the 1st molar (mm) in three groups using Mean, Standard deviation and Post Hoc Tukey test

Distance between the anterior fibres distal to the 1st molar (mm)	Mean	S.D.	P - value
Vertical group	17.30	1.64	0.000
Horizontal group	13.30	2.00	0.009
Average group	14.60	1.96	0.283

Statistically significant if P<0.05

Table 2- Statistical measurements assessing the Distance between the anterior fibres of masseter muscle distal to the 1st molar (mm) in three groups using Mean, Standard deviation and Post Hoc Tukey test

Distance between the posterior fibres distal to the 1st molar (mm)	Mean	S.D.	P - value
Vertical group	52.70	1.64	0.000
Horizontal group	57.60	1.71	0.000
Average group	56.60	1.71	0.394

Statistically significant if P<0.05

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Table 3- Statistical measurements assessing the Orientation of the muscle fibres (degrees) of masseter muscle in three groups using Mean, Standard deviation and Post Hoc Tukey test

Orientation of the muscle fibres (degrees)	Mean	S.D.	P - value
Vertical group	64.60	2.22	0.000
Horizontal group	72.70	1.49	0.068
Average group	68.00	1.76	0.001

Statistically significant if P<0.05

DISCUSSION

There are very few authors in the literature who have measured the distance between the fibres and the 1st molar antero-posteriorly. This has a clinical relevance in the concept of natural anchorage provided by the muscular tissue over the posterior teeth. In this study these measurements are taken in an axial view as the distance between the anterior fibres to the distal aspect of the 1st molar and in the same manner, the distance between the posterior part of the fibres distal to the 1st molar are measured. This gives us an idea of the location of the masseter muscle fibres distal to the posterior teeth and can explain the more loss of anchorage seen in the vertical growth patterns when compared with horizontal and average growth patterns. The anterior fibres in vertical group are at a greater distance posteriorly from the 1st molar when compared with the horizontal and average groups, so their influence on 1st molar as muscular anchorage, is less.These results are also consistent and support the hypothesis of Haas et al56 who proposed that the molars were relatively more anterior to the masseter in hyperdivergent vertical facial patterns, and posteriorly placed in hypodivergent overclosed facial patterns. These findings also support the study done by Sassouni and Nanda who suggested that in a dolicocephalic individual the fibres of the muscle are directed more posteriorly because they are attached at amore posterior position at the angle of the mandible. In the horizontal group where there is an increased width of the masseter muscle at the level of insertion, the anterior fibres are closer to the 1st molar whereas the posterior fibres are farther from it.[12]The concept of muscular anchorage by Bench et al is also supported by these results who hypothesized that, the teeth would be controlled with natural anchorage in a brachyfacial pattern, due to the position and anatomy of the strong musculature involved. Hence anchorage loss of the posterior teeth while using retraction mechanics is less or negligible in case of a brachycephalic individual when compared with the dolicocephalic or mesocephalic individuals.[15]The results of the present study are in concurrence with the observations of other studies who considered occlusal plane as the reference plane to measure the orientation of the fibres. Haskell et al reported that the superficial masseter was angled considerably more anteriorly with a much more acute angle to the occlusal plane in a dolicofacial specimen when compared with a brachyfacial specimen.[16]The relationship between the growth patterns of the skull and orientation of the muscle fibers in subjects is explained by Van Spronsen et al [6] who stated that subjects with increased vertical craniofacial dimensions having relatively obliquely oriented jaw muscles showed a consequent reduced potential to restrain the vertical component of craniofacial growth.

CONCLUSION

In our study, we noticed that the orientation of muscle fibres is directed more posteriorly and at a more acute angle whereas in horizontal group the fibres are vertically oriented with anterior attachment at the angle of the mandible.

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REFERENCES

1. Sassouni V 1969 A classification of skeletal facial types. American Journal of Orthodontics 55: 109-123
2. Proffit W, Fields H W, Nixon W L 1983 Occlusal forces in normal- and long-face adults. Journal of Dental Research 62: 566-571
3. Ahlgren J 1966 Mechanism of mastication. Acta Odontologica Scandinavica 24 (Suppl. 44): 1-109
4. Maller E 1966 The chewing apparatus. Acta Physiologica Scandinavica 69 (Suppl. 280): 1-229
5. WeijsW A, Hillen B 1984b Relationship between masticatory muscle cross-section and skull shape. Journal of Dental Research 63: 1154-1157
6. VanSpronsen P H, WeijsW A, ValkJ, Prahl-Andersen B, Van Ginkel F C 1992. A comparison of jaw muscle cross-sections of long-face and normal adults.Journal of Dental Research 71: 1279-1285
7. Carter D R, Wong M, Orr T E 1991 Musculoskeletal ontogeny, phylogeny and functional adaptation. Journal of Biomechanics 24 (Suppl. 1): 3-16
8. Nanda S K, Merow W W, Sassouni V 1967 Repositioning of the masseter muscle and its effect on skeletal form and structure. American Journal of Orthodontics 37: 304-308
9. Hohl T H 1983Masticatory muscle transposition in primates: effects on craniofacial growth. Journal of Maxillo-Facial Surgery 11: 149-156
10. Proctor A D, DeVincenzo J P 1970Masseter muscle position relativeto dento-facial form. Angle Orthodontist 40: 37-44
11. Takada K, Lowe A A, Freund V K 1984 Canonical correlations between masticatory muscle orientation and dentoskeletal morphology in children. American Journal of Orthodontics 86: 331-341
12. Sassouni V, Nanda S 1964 Analysis of dentofacial vertical proportions. American Journal of Orthodontics 50: 801-823
13. Epker B N, O'Ryan F 1982 Determinants of Class II dentofacial morphology: I. A biomechanical theory. In: McNamara J A (ed.) The effect of surgical intervention on craniofacial growth. Monograph No. 12, Craniofacial Growth Series, Center for Human Growth and Development, University of Michigan, Ann Arbor, pp. 169-205.
14. Hannam A G, Wood W W 1989 Relationships between the size and spatial morphology of human masseter and medial pterygoid muscles, the craniofacial skeleton and jaw biomechanics. American Journal of Physical Anthropology 80:429-445.
15. Bench RW, Gugino CF, Hilgers JJ. Bioprogressive therapy: Part 6. J Clin Orthod. 1978;12:123-39.
16. Haskell B, Day M, Tetz J. Computer-aided modeling in the assessment of the biomechanical determinants of diverse skeletal patterns. Am J Orthod Dentofacial Orthop. 1986;89:363-382.