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Evaluation of change in length, volume and fiber orientation of Masseter muscle in growing skeletal Class II subjects before and after use of Twin block appliance.

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Abstract:

Objective: To evaluate and compare the masseter muscle length, volume, and fiber orientation in a skeletal class II subject before and after a twin block appliance.

Background: Orthodontic interventions play a pivotal role in the correction of malocclusions, particularly in growing individuals with Class II skeletal patterns. The Masseter muscle, a key component of the masticatory system, undergoes dynamic adaptations in response to functional appliances, influencing its length, volume, and fiber orientation. Among the various orthodontic appliances, the Twin Block has gained prominence for its effectiveness in addressing Class II discrepancies. These abstract aims to provide a comprehensive evaluation of the alterations in Masseter muscle characteristics in growing skeletal Class II subjects, both before and after the application of the Twin Block appliance. The Masseter muscle's intricate relationship with mandibular development and function underscores the significance of understanding its adaptive changes during orthodontic treatment. By employing advanced imaging techniques and quantitative assessments, we seek to elucidate the impact of Twin Block therapy on the length, volume, and fiber orientation of the Masseter muscle. A thorough exploration of these morphological changes can contribute valuable insights into the biomechanical aspects of functional appliances and their influence on craniofacial growth. The findings from this study may not only enhance our understanding of the muscular adaptations associated with Twin Block therapy but also provide clinicians with valuable information for optimizing treatment strategies in growing Class II patients. As we delve into the dynamic interplay between orthodontic appliances and muscular responses, we strive to advance the knowledge base in orthodontics and contribute to the refinement of evidence-based treatment protocols. **Methodology :** It was a prospective longitudinal study in the Department Of Orthodontics And Dentofacial Orthopaedics. The calculated sample size was 19 so rounded 20 (11-Female and 9male)patients were included in the study. The study incorporates information about the ultrasound (USG) of the Masseter muscle, highlighting its low cost and no radiation exposure to the patient in our study we have used *Samsung [RS 80 A] Ultrasonography machine, liner probe LA3- 16* A for measuring the various parameters like **length, volume, and fiber orientation of Masseter muscle.** The statistical analysis was done by SPSS 21 statistical software for windows 11.

Results: This study investigates the morphological changes in the masseter muscle, focusing on its length (Bishara SE, 1989), volume, and Fiber orientation in growing skeletal Class II subjects before and after the application of the Twin Block appliance. With respect to Masseter Muscle Length: There was highly significant differences across time points for both the right and left sides, as evidenced by the repeated measures ANOVA ($F = 15.345$ for the right and $F = 17.498$ for the left) and the associated p-values ($p < 0.001$**). There were significant differences in masseter muscle volume across the assessed time points, emphasizing the effectiveness of the Twin Block appliance. The repeated measures ANOVA results ($F = 5.981$ for the right and $F = 9.349$ for the left) and associated p-values ($p = 0.032$* for the right and $p < 0.001$** for the left) underscore the statistical significance of these volumetric alterations. Statistically significant of these changes, with repeated measures ANOVA ($F = 24.023$ for the right and $F = 16.751$ for the left) and p-values ($p < 0.001$** for both sides) highlighting the highly significant differences in fiber orientation across time points was found.

Conclusion: In conclusion, the application of the Twin Block appliance in growing skeletal Class II subjects results in significant alterations in masseter muscle length, volume, and fiber orientation.

Key Words: Twin Block Appliance (TB), Masseter Muscle (MM), Skeletal Class II, Orthodontic Intervention, USG (Ultrasonography), Morphological Changes.

Introduction:

The masseter muscle (MM), a crucial element of the masticatory system (MS), plays an essential role in defining facial aesthetics and ensuring proper oral function. This strong muscle, which facilitates jaw movement during chewing, greatly contributes to the overall balance of the craniofacial complex. Skeletal (SK) Class II malocclusion (CL-IIM), characterized by an improper relationship between the maxilla and mandible, poses complex challenges both functionally and aesthetically. This misalignment often leads to facial proportion imbalances, affecting the facial profile and, consequently, the individual's self-esteem and social interactions. Additionally, CL-IIM significantly alters the MS, impairing bite function and potentially causing temporomandibular joint disorders [1].To address the issues associated with SK CL- IIM, strategic orthodontic interventions are required. Among these, the Twin Block (TB)appliance, introduced by Clark in the 1980s, has become a widely used functional orthopaedic device aimed at promoting favorable mandibular growth patterns. The appliance seeks to correct the malocclusion by encouraging mandibular advancement and fostering a harmonious skeletal relationship [2]. As orthodontic treatments advance, it is crucial to examine not only dental and skeletal changes but also the impact of these interventions on associated musculature, such as the masseter muscle. Although previous studies have explored the effects of functional appliances on craniofacial structures, there is still a significant gap in understanding how these interventions affect the masseter muscle in growing SK Class II subjects [1-3].

Twin Block Appliance [4-6] Developed by William J. Clark in the 1980s, the TW appliance represents a major advancement in orthodontic treatment. This functional orthopedic device gained recognition for its innovative method of addressing SK CL-II M Clark's concept was based on using functional forces to direct skeletal growth, creating a foundation for improved occlusion. The TB appliance features a dual-block design with upper and lower components working together to adjust the mandible's position and orientation. This unique design allows for a customizable and patient-specific approach, accommodating individual craniofacial variations[4-6].

The principles behind the TB appliance focus on mandibular advancement. By encouraging the forward movement of the mandible, the appliance aims to utilize the growth potential of the lower jaw during developmental stages. This approach not only addresses the immediate malocclusion but also promotes favorable skeletal growth patterns over time. The TB appliance applies forces to the mandible to stimulate beneficial SK changes, aligning with the goal of achieving a balanced and aesthetically pleasing facial profile. The appliance's potential impact on skeletal growth patterns is of great interest in orthodontic research. Comprehensive studies of its effects on the craniofacial skeleton, particularly in growing individuals with CL-IIM, are essential for refining treatment protocols and understanding its long-term effects. Ultrasonography (USG) has become an invaluable diagnostic tool in dentistry and orthodontics, offering a non-invasive method to evaluate soft tissues, including the MM. In the context of this study, USG shows great potential for identifying changes in masseter muscle length and structure before and after using the Twin Block appliance in growing skeletal Class II subjects.

Overall, ultrasonography (USG) offers a non-invasive way to study changes in the MM during and after the use of the TB appliance. Complementing cephalometric analyses, USG provides dynamic, real-time imaging that enables precise measurement of muscle length, assessment of muscle volume, and visualization of muscle Fiber orientation [24].The Muscle system, consisting of the mandible's movable muscles, maxillae and mandible bones, teeth, joints, and neurovascular components, is intricately organized. Bone biomechanics, stress, and movement influence bone structure through modelling and remodelling, highlighting the functional connection between muscles and bones. The teeth and jaws experience frequent stresses from the masticatory apparatus, leading to bone deformation and eventual morphologicaladaptation[18],[19]The two genetic components that influence facial growth are muscle strength and bone length. Craniofacial development can be impacted by deformities caused by progressive weakness or overuse of the mandibular elevator muscles[20,21]Class II malocclusion is corrected with removable functional appliances like the TB, which change the morphology and structure of the masticatory muscles [22-30].

Materials and Method: **Study Design**: The study was prospective and longitudinal. **Study population**: Patients visiting the Department of Orthodontics and Dentofacial Orthopedics for seeking orthodontic treatment and the subjects were considered for the study as per the inclusion and exclusion criteria. **Inclusion Criteria:** Age group – 10 to 14 years, Angle's Class II division 1 malocclusion, Skeletal class II with retrognathic mandible, Average to Horizontal growth pattern **,**Positive VTO [visual treatment objective] The written consent will be taken from the patient's parent **Exclusion criteria:** Subject with **,** Angle's Class II division 2 malocclusion**,** Skeletal Class II with Prognathic Maxilla**,** Craniofacial disorder and skeletal deformity, Congenital developmental anomalies of the face, Patient whose growth is completed were excluded from our study.

Data analysis: Utilizing the Statistical Package for Social Science (SPSS) version 21 for Windows (SPSS Inc., Chicago, IL), statistical analysis was carried out. Ultrasonographic measurements for the masseter muscle length, volume and Fiber orientation will be measured at T-0 Start of treatment [without appliance] T 1 Start of treatment [with appliance], T 2 End of treatment [after 6 months] without appliance.

Samsung [RS 80 A] USG machine, with linear Array probe/transducer LA3- 16 A [3 to 16 MHz high Frequency Linear probe] is used for USG of the Masseter muscle length, volume, and Fiber orientation

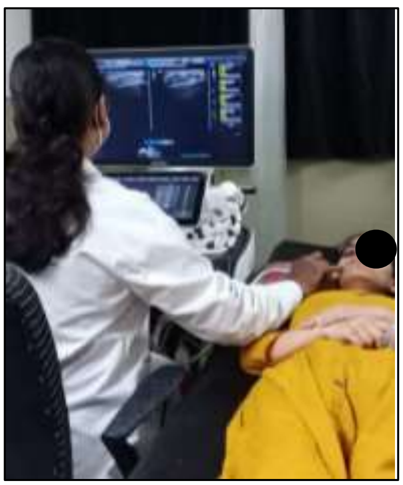


Fig.9A: USG-Procedure of the masseter muscle Length

Fig.9 B: USG-Masseter muscle Length

Fig.9 C: USG-Masseter muscle Length

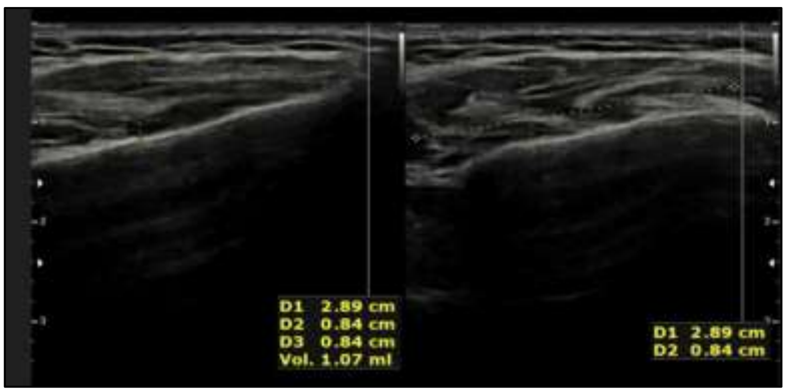


Fig 2E- USG-Volume of the Masseter Muscle

Fig.2 E: USG of the Masseter muscle fiber orientation

Results:

LENGTH OF MASSETER MUSCLE:

Table 1: Descriptive statistics of masseter muscle length in growing skeletal class II subject before and after use of Twin block appliance

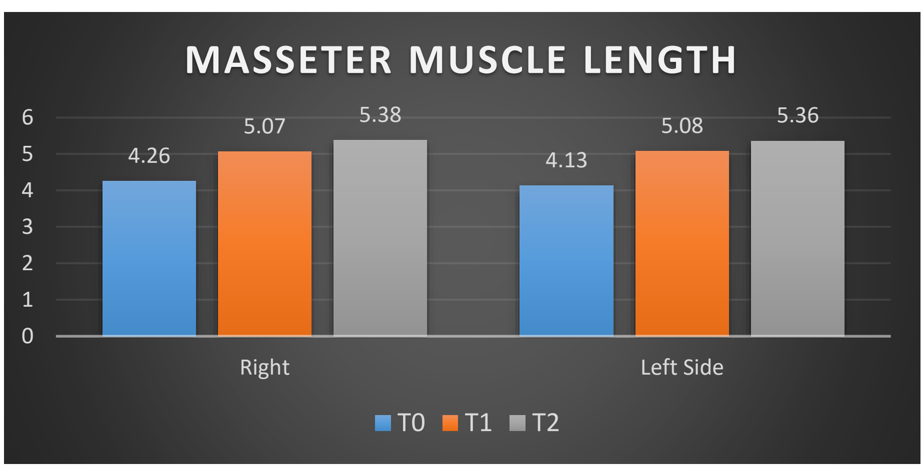
Right Side	Mean	SD	SE	Minimum	Maximum
T0	4.26	0.58	0.15	3.23	5.43
T1	5.07	0.68	0.17	4.02	6.25
T2	5.38	0.39	0.10	4.59	5.99
Left Side	Mean	SD	SE	Minimum	Maximum
T0	4.13	0.54	0.14	3.01	5.43
T1	5.08	0.57	0.14	3.78	6.04
T2	5.36	0.65	0.16	4.05	6.84

Table 2: Comparison of masseter muscle length in growing skeletal class II subject before and after use of Twin block appliance

	Right Side Mean (SD)	**Left Side Mean (SD)**
T0	**4.26 (0.58)**	**4.13 (0.54)**
T1	**5.07 (0.68)**	**5.08 (0.57)**
T2	**5.38 (0.39)**	**5.36 (0.65)**
Repeated Anova F test value	**F = 15.345**	**F = 17.498**
P value, Significance	**p < 0.001****	**p < 0.001****
T0 vs T1^	**p =0.001***	**p < 0.001****
T0 vs T2^	**p < 0.001****	**p < 0.001****
T1 vs T2^	**p =0.048***	**P =0.28***

***p<0.05 – significant** ****p< 0.001 – highly significant**

^p value (pairwise) calculated using Tukey's post hoc test



Graph 1: Comparison of masseter muscle length in growing skeletal class II subject before and after use of Twin block appliance.

	Right Side Mean (SD)	Left Side Mean (SD)
T0	**5.64 (1.0)**	**5.10 (0.88)**
T1	**6.55 (0.97)**	**6.55 (1.03)**
T2	**6.93 (2.6)**	**7.04 (1.75)**
Repeated Anova F test value	**F = 5.981**	**F = 9.349**
P value, Significance	**p =0.032***	**p < 0.001****
T0 vs T1^	**p =0.048***	**p =0.009***
T0 vs T2^	**p =0.036***	**p < 0.001****
T1 vs T2^	**p =0.182**	**p = 0.128**

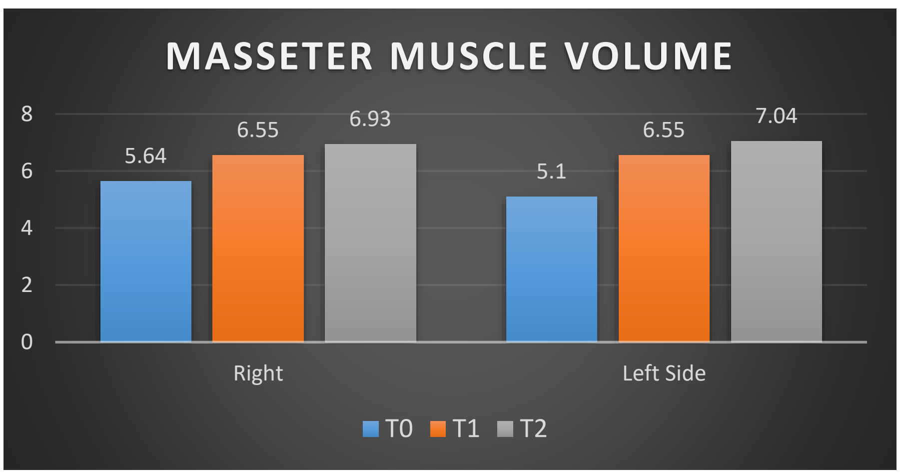
Table 3: Descriptive statistics of volume in growing skeletal class II subject before and after use of Twin block appliance

Right Side	Mean	SD	SE	Minimum	Maximum
To	**5.64**	**1.0**	**0.25**	**4.0**	**7.17**
T1	**6.55**	**0.97**	**0.25**	**4.71**	**7.87**
T2	**6.93**	**2.6**	**0.67**	**2.50**	**11.07**
Left Side	**Mean**	**SD**	**SE**	**Minimum**	**Maximum**
To	**5.10**	**0.88**	**0.22**	**3.41**	**6.35**
T1	**6.55**	**1.03**	**0.26**	**4.26**	**7.87**
T2	**7.04**	**1.75**	**0.45**	**4.05**	**10.47**

Table 4: Comparison of masseter muscle volume in growing skeletal class II subject before and after use of Twin block appliance

(p>0.05 – no statistically significant difference *p<0.05 – significant **p< 0.001 – highly significant ^p value (pairwise) calculated using Tukey's post hoc test)

Repeated ANOVA F Test Value: The F test values for repeated measures ANOVA are reported for both the right (F = 5.981) and left (F = 9.349) sides, indicating the statistical significance of changes in masseter muscle volume across the assessed time points. This table provides a comprehensive overview of the changes in masseter muscle volume, offering valuable insights into the impact of Twin Block appliance use on the masticatory muscles in growing skeletal Class II subjects.



Graph 2 : Comparison of masseter muscle volume in growing skeletal class II subject before and after use of Twin block appliance

FIBRE ORIENTATION:

Table 5: Descriptive statistics of fibre orientation in growing skeletal class II subject before and after use of Twin block appliance

Right Side	Mean	SD	SE	Minimum	Maximum
T0	74.91	7.89	2.03	63.24	89.5
T1	84.99	7.43	1.91	73.24	96.98
T2	93.16	6.24	1.61	80.37	99.04
Left Side	Mean	SD	SE	Minimum	Maximum
T0	5.2	5.47	1.411	70.02	87.37
T1	6.04	5.35	1.38	80.01	96.98
T2	5.68	6.29	1.62	79.04	98.15

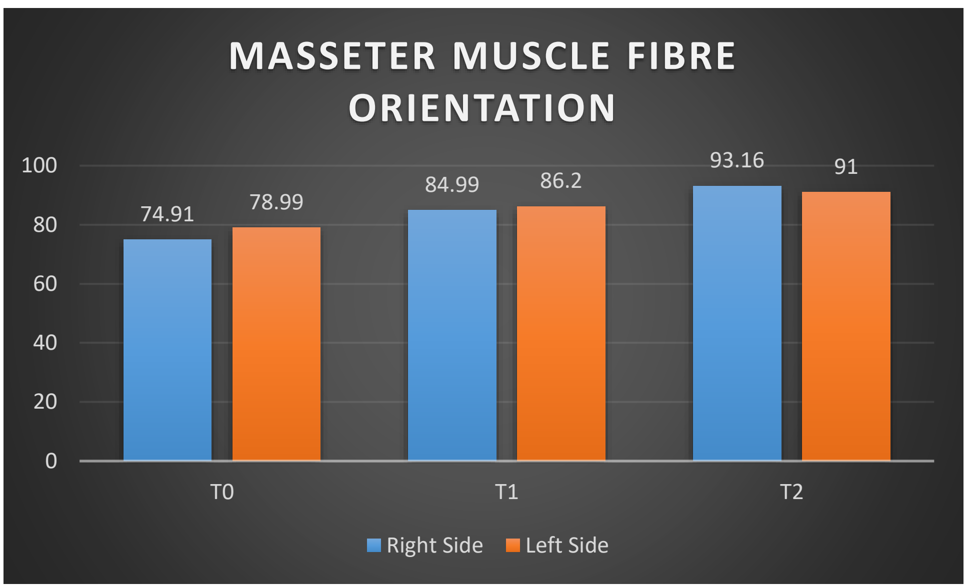
Overall, the data suggests an increase in fibre orientation on the right side over the course of treatment, while the left side shows relatively stable fibre orientation with some fluctuations.

Table 6: Comparison of masseter muscle fibre orientation in growing skeletal class II subject before and after use of Twin block appliance

	Right Side Mean (SD)	Left Side Mean (SD)
T0	74.91 (7.89)	78.99 (5.47)
T1	84.99 (7.43)	86.2 (5.35)
T2	93.16 (6.24)	91.0 (6.29)
Repeated ANOVA F test value	F = 24.023	F = 16.751

P value, Significance	**p < 0.001****	**p < 0.001****
To vs T1^	**p =0.001***	**p =0.004***
T0 vs T2^	**p < 0.001****	**p < 0.001****
T1 vs T2^	**p =0.01***	**p =0.045***

(p>0.05 – no statistical significant difference *p<0.05 – significant **p< 0.001 – highly significant ^p value (pairwise) calculated using Tukey's post hoc test) Overall, the data suggests a significant increase in masseter muscle fibre orientation on both the right and left sides after the use of the Twin block appliance, with some differences in the rate of change between the sides.



Graph 3: Comparison of masseter muscle fibre orientation in growing skeletal class II subject before and after use of Twin block appliance

Discussion:

The use of orthodontic equipment, such as the Twin block, to rectify malocclusions is a well-established practice in orthodontics, especially for managing skeletal Class II malocclusions. Our study sought to analyze the Twin block appliance's effect on the morphological and functional characteristics of the Masseter muscle, specifically changes in length, volume, and fiber orientation in growing skeletal Class II participants. The large changes found in the Masseter muscle post-treatment show the appliance's capacity to significantly modify muscle morphology and function, in addition to its primary role in dental correction [73].

Extensive study has demonstrated the Masseter muscle's responsiveness to orthodontic treatments, highlighting its critical role in masticatory function and the orthodontic treatment environment. Our findings add to this body of knowledge by describing the precise morphological changes generated by the Twin block appliance, which are consistent with prior research that have revealed muscle adaptation in response to orthodontic therapies. These adaptations indicate the muscle's dynamic reaction to the altered functional demands imposed by such equipment [74].Orthodontic procedures in growing skeletal Class II patients offer the potential to rectify malocclusions while also promoting favorable craniofacial growth and development. The data we report imply that the Twin block appliance not only aids in malocclusion correction, but may also generate favorable adjustments in muscle structure that promote orofacial function and aesthetics over time [75].

Furthermore, our findings are consistent with other studies that have investigated the long-term effects of functional appliance therapy on face muscles, revealing significant changes in muscle activity and craniofacial structure. Studies using MRI to investigate the effects of the Twin block device on the Masseter muscle have provided important insights into the physiological and biomechanical mechanisms driving these modifications. Such research highlights the complexities of muscle adaptation and its consequences for orthodontic practice, including treatment planning, appliance design, and patient management.[76]

P Value, Significance: The corresponding p-values are provided for the F tests, indicating the level of statistical significance. Notably, the p-values for the left side are reported as $p < 0.001$**, signifying a highly significant difference.

FIBRE ORIENTATION- Overall, the data suggests a significant increase in masseter muscle fibre orientation on both the right and left sides after the use of the Twin block appliance, with some differences in the rate of change between the sides.

The study sought to compare changes in the length, volume, and fibre orientation of the masseter muscle in growing skeletal Class II subjects before and after utilizing the Twin block device. The findings revealed significant changes in all three measures over the duration of the treatment. Masseter Muscle Length: Both the right and left sides of the masseter muscle increased significantly in length from T0 (before therapy) to T2 (after treatment). The average length grew from 4.26 to 5.38 on the right side and 4.13 to 5.36 on the left. Masseter muscle volume increased significantly on both sides from T0 to T2. The average volume increased from 5.64 to 6.93 on the right side and 5.10 to 7.04 on the left. Fiber Orientation: Fiber orientation increased significantly on both sides of the masseter muscle from T0 to T2. The average fiber orientation rose from 74.91 to 93.16 on the right side and from 78.99 to 91.00 on the left.

Conclusion

This study found that using twin-block appliances in growing patients with Class II skeletal discrepancies led to significant changes in the masseter muscle's thickness, volume, and fiber orientation, as assessed by ultrasonography (USG). These alterations suggest improvements in muscle function and facial aesthetics, highlighting the appliance's effectiveness in correcting skeletal discrepancies and influencing masticatory muscles. The non-ionizing, cost-effective, and dynamic nature of USG makes it suitable for pediatric patients. Further research with larger sample sizes and longer follow-up periods is necessary to confirm these findings and understand their long-term implications for oral health and function.

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