ORIGINAL RESEARCH

Cephalometric Evaluation of the Pre- and Posttreatment Changes after the Correction of Class II Division 1 Malocclusion with Twin Block Appliance in Mixed Dentition

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Abstract

Aim and objective: To evaluate the pretreatment cephalometric records on the dental, skeletal, soft tissue, and incisor relationship with a twin block functional appliance in class II malocclusion patients in and around Mahe; evaluate the posttreatment cephalometric records on the dental, skeletal, soft tissue, and incisor relationship with a twin block functional appliance in class II malocclusion patients in these children; and to compare cephalometrically certain dental, skeletal, and soft tissue points in pretreatment and posttreatment cephalograms in them.

Materials and methods: This study was conducted on 20 class II patients in the mixed dentition period, who were treated with twin block therapy. Each had to meet the following criteria—(1) skeletal class II malocclusion with retrognathic mandible; (2) full cusp class II molar relationship; and (3) an angle of ANB of 50 or greater at the start of treatment. All patients wore the appliance 24 hours/day. The pretreatment cephalometric head films for the group were taken using standard cephalometric X-ray equipment. The length of time required to achieve a class I molar relationship was assessed. Appointments during the twin block phase were scheduled at intervals of 8 weeks. Lateral head films were obtained again at the posttreatment follow-up stage.

Results: There was a significant increase in effective mandibular length, ramus height, SNB, ANB, overjet, overbite, and I to NA (mm and degrees) after twin block therapy. The maxillary incisor position showed a decrease in its value by 4° in five cases.

Conclusion: Thus, in the present study, evidence of skeletal and dentoalveolar changes leading to the correction of class II division 1 malocclusion with the twin block functional appliance has been established. However, further studies with a longer period of follow-up and a larger sample are required to substantiate the results of the present investigation.

Keywords: Cephalometric landmark, Mixed dentition, Orthodontic appliance, Twin block.

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Introduction

Class II malocclusion can be defined as a condition in which the mandibular first molars occlude distal to the normal relationship with the maxillary first molars. Two sections can be distinguished—section 1 is the protrusion of the upper incisors, and section 2 is the retroclination and proclination of the upper posterior teeth. The classification of angle is in line with this. The British Dental Institute, on the contrary, defined class II in 1983 as a situation where there is an increase in overjet and the lower incisors lie behind the proclined or averagely inclined upper incisor cingulum plateau.[1,2]

Class II malocclusion can be caused by a variety of skeletal, soft tissue, dental, and habitual factors. Angle reports that class II is highly prevalent, at roughly 27%.

For tooth movement and skeletal growth modification, class II functional appliances are indicated. They help in the correction of mandibular deficiencies by allowing mandibular postural changes through holding the mandible forward and/or downward. Both fixed and removable class II functional appliances are used to improve class II malocclusions. Since the success with removable appliances largely depends on the patient's compliance, using a more tolerable appliance can increase the chances of a favorable outcome.[3,4]

Class II malocclusions can present with a range of skeletal and dental configurations. Anteroposterior jaw position deficiencies affect the majority of class II patients. The use of functional appliance therapy to treat class II malocclusion is growing in popularity. For many years, a number of functional appliance types, including Herbst, Bionator, FR-2 of Frankel, and twin block, have been used to treat class II division 1 malocclusions and correct skeletal imbalances.[5,6]

Scottish orthodontist William Clark created the twin block appliance, a useful orthopedic appliance, in 1977. It is made up of distinct upper and lower parts that fit snugly into the alveolus or tooth socket and supporting tissues. The appliance guides the

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mandible or lower jaw forward and downward with its occlusal inclined planes, which meet at a 70° angle.

It is well known that class II malocclusions, which are defined by the lower jaw being positioned farther back than the upper jaw, are most frequently treated with this appliance. Compared to other orthodontic appliances, patients typically tolerate the twin block appliance well. Class II malocclusions are prevalent among child patients, and effective methods for modifying maxillary (upper jaw) or mandibular (lower jaw) growth patterns in these cases are actively researched. Functional appliances like the twin block have been studied extensively for their ability to achieve skeletal correction in developing malocclusions, albeit with varying degrees of success.

However, there remains limited scientific literature specifically evaluating the effectiveness of the twin block appliance in mixed dentition (a stage where both primary and permanent teeth are present).

The twin block appliance is a functional orthodontic device that modifies the occlusal inclined plane by means of distinct upper and lower components. By using the posterior teeth's advantageous occlusal forces to propel the mandible forward into proper alignment, this configuration enables quick correction of malocclusion.

As the occlusal surfaces of the twin block have inclined planes, when the device is placed in the mouth, it encourages the mandible to adopt a protrusive bite. By replacing unfavorable cuspal contacts linked to distal occlusion, this shift promotes corrective proprioceptive contacts with the inclined planes of the twin block. This mechanism allows the mandible to move out of its locked, distal functional posture and aids in malocclusion correction. Specifically, the twin block consists of:

- Upper and lower double acrylic resin plaques anchored on the first molars and first premolars.
- A vestibular arch extending from the right canine to the left canine.
- Bite blocks inclined at approximately 65–70°, facilitating mandibular advancement.
- The lower resin plaque includes a delta clasp on the first molar and ball clasps in the anterior interproximal areas.
- Bite blocks are positioned mesially at the distal marginal edge of the second premolars.

The twin block's design divides the upper and lower plates, improving its functionality and efficacy in guiding mandibular growth and correcting malocclusion. Other removable functional appliances are usually monoblocks. To ensure optimal fit and functionality, the appliance's construction is based on bite registrations taken with the incisors in an end-to-end position. Additional auxiliary components, such as transverse expansion screws, can be added if the upper jaw contracts, while sagittal springs and screws can be added to recover arch space. The appliance may be used in conjunction with extraoral traction or traction with clamps placed on lower molar clasps and upper vestibular arch bends to help with the correction of maxillary protrusion.

One of the most crucial elements of a successful functional appliance treatment plan is patient cooperation. The twin block is less bulky than other functional devices, which increases patient compliance, provides patients with significant movement freedom in their mandibles, and reduces speech disturbance.

Aims and Objectives

- To evaluate the pretreatment cephalometric records on the dental, skeletal, soft tissue, and incisor relationship with the twin block functional appliance in class II malocclusion patients in and around the Malabar region.
- To evaluate the posttreatment cephalometric records on the dental, skeletal, soft tissue, and incisor relationship with the twin block functional appliance in class II malocclusion patients in these children.
- To compare cephalometrically certain dental, skeletal, and soft tissue points in pretreatment and posttreatment cephalograms in them.

Materials and Methods

After receiving clearance from the Ethical Committee of Mahe Institute of Dental Sciences and Hospital, Puducherry, India, this study was conducted on 20 class II patients in the mixed dentition period who were treated with twin block therapy in the Department of Pediatric and Preventive Dentistry.

Each had to meet the following criteria:

- Skeletal class II malocclusion with a retrognathic mandible.
- Malocclusion with a full cusp class II molar relationship.
- Class II malocclusion with an ANB angle of 5.0 or greater at the start of treatment.

Inclusion Criteria

- Skeletal class II relationship as observed on cephalometric radiograph and study model.
- Class II canine and molar relationship.
- Patients from whom parental consent could be obtained.

Exclusion Criteria

- Syndromic patients were excluded.
- Medically compromised patients and physically or mentally challenged patients were excluded.
- Patients with severe maxillary prognathism or mandibular deficiency that required surgical intervention were excluded.

Design of Twin Block

The maxillary and mandibular removable acrylic plates were secured to the first permanent molars using 0.8 mm Adams clasps as part of the twin block appliance utilized for treatment. To help retain the maxillary incisors in the anterior position and to retrocline them if they are proclined, a passive maxillary labial bow was added. The interproximal areas of the mandibular acrylic plate were equipped with 0.9 mm ball clasps.

Every patient was required to wear the device all day long. Using standard cephalometric X-ray equipment, the group's pretreatment cephalometric head films were taken. The amount of time needed to achieve a class I molar relationship was evaluated. During the twin block phase, appointments were scheduled every 6–8 weeks. A second set of lateral head films was taken during the posttreatment follow-up phase.

Results

We selected 20 children in our study who had been treated with the twin block appliance in the Department of Pediatric Dentistry with a follow-up duration of 8 months. The distribution of study subjects included 7 males and 13 females (Table 1). Tracing was done by hand using a sharp 3H pencil on acetate tracing paper in a dark room using an X-ray viewer. The important hard and soft tissue structures were marked on a lateral cephalograph, and various reference points, planes, and angles were drawn and recorded for evaluation. Angles were measured to the nearest 0.5°. To reduce intraoperator errors, all measurements were repeated after 1 week (Figs 1 and 2).

After the 8-month follow-up, 17 parameters were taken for comparison. Statistical analysis was done using Statistical Package for the Social Sciences (SPSS) software, and a paired *t*-test was used for comparing the values (Table 2).

Table 1: The distribution of study subjects according to gender

Gender	*Number*	*Mean age*	*Standard deviation (SD)*	*Standard error mean*
Males	7	9.4286	1.13389	0.42857
Females	13	10.3846	0.96077	0.26647

The S line, representing the soft tissue points, was one of the parameters in our study. Among 20 cases, 19 children had protrusive upper and lower lips preoperatively, while one patient had retrusive upper and lower lips. After twin block therapy, three patients' lip profiles became normal, 16 patients still had protrusive upper and lower lips, and one patient remained retrusive. The Wilcoxon signed ranks test Z was insignificant (Table 3).

Table 3: Assessment of one of the soft tissue parameters, S line

S line	*Protrusive upper and lower lip*	*Retrusive upper and lower lip*	*Normal*	*Total*
Preoperative	19	1	0	20
	84.2%	0.0%	15.8%	100.0%
Postoperative	16	1	3	20
	0.0%	100.0%	0.0%	100.0%

Wilcoxon signed-rank test, $Z = -1.732$, asymptotic significance (two-tailed), $p = 0.083$

Table 2: Comparison of mean preoperative and postoperative values of different parameters among study subjects

		Mean	*SD*	*t-value*	*p-value and significance*
Effective mandibular length (Ar-Gn)	Preoperative	8.55	1.079	−2.153	0.044
	Postoperative	8.94	0.931		
Ramus height (Ar-Go)	Preoperative	3.62	0.466	−2.793	0.012
	Postoperative	3.91	0.343		
Overjet	Preoperative	9.05	1.761	11.501	0.000
	Postoperative	5.45	1.833		
Overbite	Preoperative	5.15	1.631	3.263	0.004
	Postoperative	3.90	0.967		
Interincisal angle	Preoperative	118.05	8.786	−1.992	0.061
	Postoperative	121.85	5.122		
I to NA (degree)	Preoperative	30.85	5.091	3.950	0.001
	Postoperative	26.05	4.382		
I to NA (mm)	Preoperative	6.30	1.525	6.474	0.000
	Postoperative	4.60	1.353		
I to NB (degree)	Preoperative	23.90	6.995	−2.024	0.057
	Postoperative	26.45	5.889		
I to NB (mm)	Preoperative	4.70	1.894	−1.318	0.203
	Postoperative	5.30	2.341		
SNA	Preoperative	80.40	4.031	−1.798	0.088
	Postoperative	81.20	3.981		
SNB	Preoperative	74.45	3.531	−6.458	0.000
	Postoperative	76.75	3.242		
ANB	Preoperative	5.95	1.669	5.253	0.000
	Postoperative	4.50	2.212		
Maxillary incisor position (U1-SN) degree	Preoperative	67.45	5.960	−3.480	0.003
	Postoperative	71.45	4.071		
Mandibular incisor position (L1-GoGn) degree	Preoperative	99.30	8.766	−1.196	0.247
	Postoperative	101.95	7.687		
Anterior facial height (N-Me)	Preoperative	9.37	1.207	−1.866	0.078
	Postoperative	9.71	1.097		
Y-axis (Sella to Gn)	Preoperative	9.59	1.407	−2.030	0.057
	Postoperative	9.98	1.262		
Z angle	Preoperative	83.45	5.175	−1.750	0.096
	Postoperative	84.90	5.139		

Fig. 1: Lateral cephalogram of the patient—preoperative

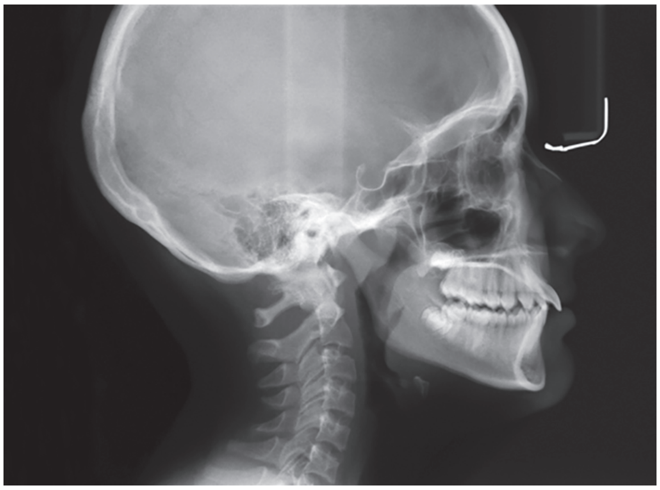

Fig. 2: Lateral cephalogram of the patient—postoperative

Figure 3 represents the final results of our cephalometric study with twin block therapy. The study indicated that effective mandibular length and ramus height increased after the treatment (0.044, 0.012 respectively). We also found a significant difference in overjet and overbite, both being reduced and statistically very significant (0.000, 0.004). The I to NA (mm) value reduced after twin block therapy, and this reduction was found to be statistically very significant (0.000). Conversely, the I to NB (mm) value was found to increase, but this was not statistically significant (0.203). The ANB value decreased after treatment, and the reduction was statistically highly significant (0.000). Anterior facial height (0.078) and Y-axis (0.057) values increased after the treatment concluded, but the statistical significance of facial height was negligible.

In Figure 4, the interincisal angle showed an increased value after treatment, but the statistical difference was minimal (0.061). The I to NA (degree) value showed a highly significant decrease (0.001). The I to NB (degree) value decreased but was not statistically significant (0.057). The SNB value markedly increased after treatment, with very high statistical significance (0.000). The maxillary incisor position showed a decrease, and the statistical significance was notable (0.003). The mandibular incisor position and Z-angle values increased after the 8-month follow-up, but the statistical significance was negligible (0.247, 0.096).

Discussion

In our study, we evaluated pretreatment and posttreatment changes after the correction of class II division 1 malocclusion with the twin block appliance in mixed dentition. Around 17 parameters were analyzed to evaluate the effects over an 8-month follow-up period.

In the current study, we discovered that, following treatment with a twin block appliance for class II division 1 malocclusion, the effective mandibular length increased on cephalometric assessment by a maximum of 2.4 mm.[7] In their investigations, several authors found that twin block therapy caused the mandible to elongate similarly.[8,9–11] After twin block therapy, the anterior facial height and ramus height in the majority of our study samples

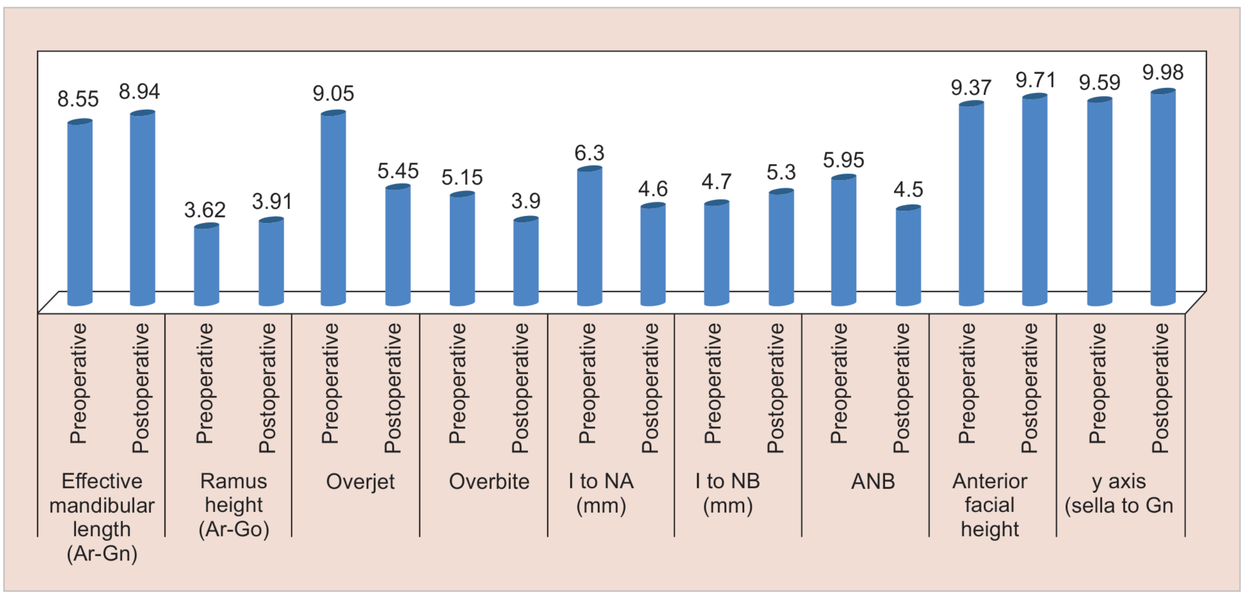

Fig. 3: Mean preoperative and postoperative values of different parameters among study subjects

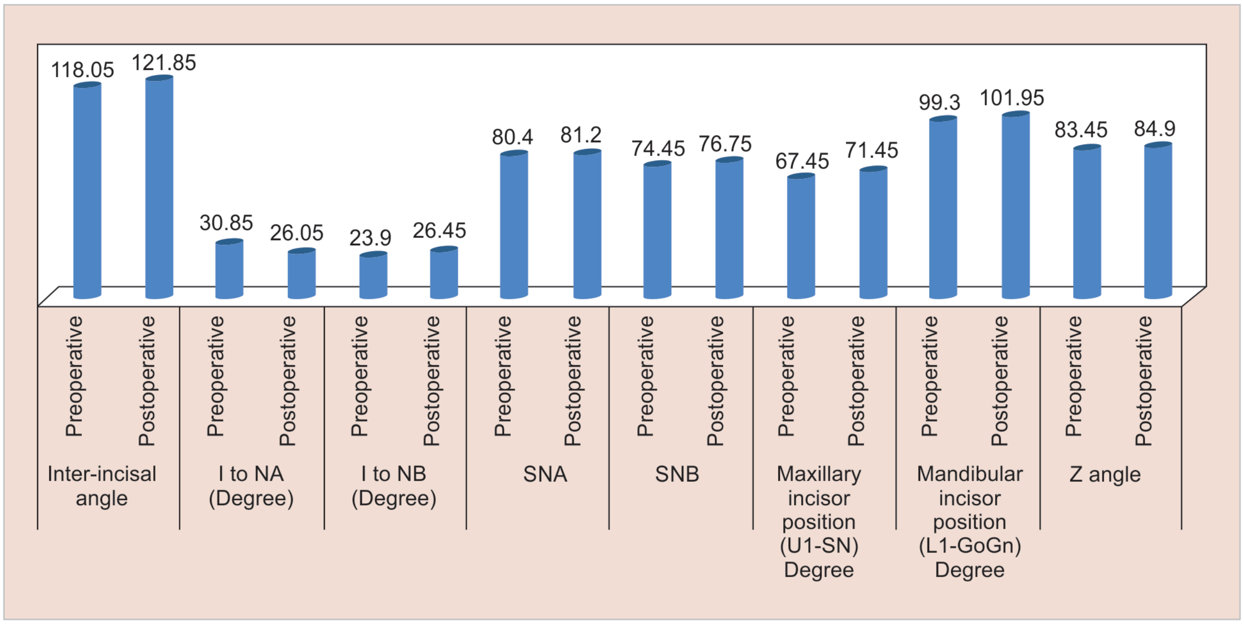

Fig. 4: Mean preoperative and postoperative degree values of different parameters among study subjects

increased significantly. As a result, the rotational component of growth in a vertical direction was reduced.[12]

According to a study by Sharma et al., mandibular length increased significantly by 7.1 mm after receiving twin block therapy. The combined effects of normal growth increment, the appliance's effect of forward posturing of the mandible, and the mandible's downward and backward rotation (posterior mandibular morphogenetic rotation) contributed to this increase in effective mandibular length. The mandibular base and ascending ramus were found to have significantly increased in length by 2.7 mm, indicating a statistically significant change.[13] According to our research, the ramus length increased by a maximum of 1.6 mm.

Mills studied how functional appliances affected the skeletal pattern.[6] After a 10-month follow-up with twin block therapy, focusing on children aged 8–13, they discovered a significant decrease in overjet, which resulted from a combination of the mandible moving forward and the maxillary incisors tipping backward. A comparable finding of a 6 mm reduction in overjet was observed in our study of children, and it was statistically significant.[3,14]

After the 8-month follow-up, our children's cephalometric evaluation revealed that while SNB and ANB angles had significantly decreased, SNA angles had not changed. With no changes to the maxillary skeleton, Lund and Sandler also discovered that the most notable change with the twin block appliance was the increase in the angle between cephalometric points S, N, and B (SNB).[8]

According to a study by Sharma et al.,[13] the SNA angle decreased by a mean of 0.5 ± 0.70, indicating that the maxilla's forward growth is constrained. Additionally, our study shows that the SNA angle can drop by up to 5°; however, statistical significance was lacking. Trenouth states that a reciprocal force acting distally on the maxilla prevented its forward growth when the mandible was positioned forward by the twin block appliance. An ideal scenario for correcting a class II skeletal discrepancy would involve hindering the maxilla's normal forward growth.[15]

Our study participants' upper incisor proclinations were reduced by up to 5 mm and 11°, which is statistically and clinically significant. A similar study by Sharma et al.[13] reports that the subjects showed a mean reduction in the upper incisor proclination (6.9°) following the twin block treatment, which is greater than what other studies have shown.[16–18] Nevertheless, this value was lower than what Illing et al. reported.

In all 20 cases in our current study, the SNB angle increased significantly and was statistically significant following Twin Block therapy. The forward shift of point B caused the SNB angle to increase significantly by a mean of 2.4 ± 1.174° in the study by Sharma et al.[13] Consequently, the mandible's anteroposterior spatial position improved in a way that was both statistically and clinically significant[19] The present study showed that the mandibular incisor position increased in the majority of cases; however, in seven cases, there was a decrease of up to 8 mm after twin block therapy during the 8-month follow-up period. This increase in the SNB angle was consistent with previously reported studies.[8,9,16,20]

Nevertheless, the proclination of the lower incisor with respect to the mandibular plane (–1.1°) following twin block treatment was not statistically significant. The ANB angle was used in our investigation to quantify the shift in the skeletal maxillomandibular relationship. After treatment, there was a highly statistically significant decrease in the angle, primarily due to the increase in SNB, which is greatly enhanced by the mandible's anterior positioning, and a slight decrease in SNA as a result of forward maxillary growth restriction. Therefore, the mandibular skeletal changes were primarily responsible for the resulting reduction in the severity of the maxillomandibular discrepancy, and the so-called headgear effect was negligible.

All of the patients in this study benefited from the correction of the mandibular discrepancy, as they all had class II malocclusion with a retrognathic mandible, and the maximum ANB angle reduction was 4 mm. To investigate the skeletal and dental effects, Lund and Sandler conducted a prospective controlled trial with twin blocks in children aged 9–12, with a treatment duration of 1.5 years. The results showed that the ANB angle decreased by 2 mm.[8] This result is consistent with findings published by Clark,[3] Illing,[7] and Mills and McCulloch.[9] Our study showed a statistically significant reduction in overbite of at least 2 mm after twin block treatment. This reduction in overbite is attributed to the combined effect of the mandible's downward and backward rotation and the molars' selective eruption. Several studies by Clark corroborate our findings.[3,12,21]

The *p*-value in our study is 0.000, and the results from I to NA were statistically very significant. This value was considerably reduced in each of the 20 cases, demonstrating the effectiveness of twin block therapy in every scenario. Studies conducted by DeVinzenzo et al. showed a similar correlation.[22] They demonstrated that the root apices might move anteriorly and point A may advance due to alveolar reshaping if the upper incisors are significantly tipped in a palatal direction. It is possible that some maxillary restraint occurred but was not noticeable because dentoalveolar remodeling masked the treatment's skeletal effects, as indicated by our study's lack of significant change in SNA.[14,15]

Our first criterion for evaluating the soft tissue profile was the S line. Of the 20 cases we examined prior to treatment, 19 had protruding upper lips, and only one had retrusive upper lips. Following twin block therapy, 16 patients still had protrusive lip profiles, one case had a retrusive upper lip, and three cases had normalized lip profiles. This demonstrates the impact of twin block therapy on lip profiles; however, the results for the S line study were not statistically significant. The discussion focuses on the results and analyses of research on how orthodontic treatment, specifically the use of functional appliances like the Twin Block, affects soft tissue landmarks. The main ideas are summarized as follows:

- Morris et al.'s findings: Morris et al. observed statistical significance in their findings regarding alterations in soft tissue, such as the length and position of the lower lip. They emphasized concerns about the clinical significance of these changes due to the large standard deviations observed. Although the changes are statistically significant, it is advisable to exercise caution when interpreting them as meaningful in clinical practice because of the variability in individual responses.
- Varlik et al.'s findings: Furthermore, Varlik et al. revealed statistically significant changes in several soft tissue landmarks. However, similar to Morris et al., they also observed significant variability in individual responses. Despite the statistical significance of their findings, this variability raises questions about their clinical relevance.
- Facial convexity and nasolabial angle: Morris et al., although their findings did not reach statistical significance, observed a minor decrease in facial convexity along with changes in the nasolabial angle and labiomental fold. This suggests that these changes might still be clinically observable, even if they are not statistically robust.
- Labiomental angle: Varlik et al. proposed that the increase in the labiomental angle observed in their study might be due to the uncurling of the lower lip, which had been trapped under the upper incisors. This highlights one possible mechanism by which orthodontic treatment may alter soft tissues.
- Challenges and considerations: Both studies note that limitations in measurement methods and individual response variability make it challenging to accurately assess changes in soft tissue. While they acknowledge that different techniques and appliances used across study sites may introduce additional sources of variability, they suggest that multicenter studies and larger sample sizes could help mitigate some of these issues.

Our research shows that, after an 8-month follow-up, there was no statistically significant difference in the Y-axis parameter among the 20 patients. However, the value increased in the majority of cases due to the forward positioning of the mandible. In a related study, Mollabashi et al. found no difference in the Y-axis, both radiographically and statistically, over a 6-month period in 9–13-year-old children with skeletal class II division 1 malocclusion and normal vertical growth patterns.[23]

The current study demonstrated an increase in the Z angle value following an 8-month twin block therapy regimen, although this change was not statistically significant. Varlik et al. conducted a study comparing the effects of activator and twin block treatments on the soft tissue profile of 50 skeletal class II patients (mean age: 11.9 ± 0.16 years; 25 boys and 25 girls). They found that, after 8 months of twin block therapy, anterior movement of the soft tissue pontion caused a significant variation in the Z angle in both the twin block and activator groups. Similar findings were also reported in 16 other studies by Bishara et al.[2,24,25]

Conclusion

Scottish orthodontist William Clark developed the twin block appliance, a functional jaw orthopedic device, in 1977. This appliance consists of mandibular and maxillary retainers that fit snugly against the teeth, alveolus, and surrounding supporting structures. It guides the mandible downward and forward using upper and lower blocks with occlusal inclined planes that interlock at a 70° angle. The twin block is considered more patient-friendly compared to other appliances for correcting class II malocclusions, making it a popular choice for managing this condition. Despite its widespread use, few studies have specifically evaluated its effectiveness in the mixed dentition phase. This study aimed to compare dental, skeletal, and soft tissue changes in pretreatment and posttreatment cephalometric records of children aged 8–11 years with class II malocclusions in the Malabar region. The objective was to assess the impact of twin block therapy on the relationships between the teeth, soft tissues, and incisors.

Our study included 20 children who received treatment with a twin block appliance in the Pediatric Dentistry Department, with an 8-month follow-up period. The cohort consisted of seven males and 13 females. Posttreatment, seventeen parameters were analyzed and compared. Statistical analysis using SPSS software and paired *t*-tests revealed significant decreases in overjet, overbite, and I to NA (both in millimeters and degrees), alongside notable increases in effective mandibular length, ramus height, and maxillary incisor position. Additionally, significant reductions were observed in the SNB, ANB, and interincisal angles, demonstrating both clinical and radiographic importance. While changes were observed in the mandibular incisor position, anterior facial height, Z angle, Y-axis, SNA, and I to NB (both in degrees and millimeters), these changes were not statistically significant.

The current study provides evidence of both skeletal and dentoalveolar changes resulting from the use of a twin block functional appliance in correcting class II division 1 malocclusion. Significant outcomes were observed in parameters including maxillary incisor position, effective mandibular length, ramus height, overjet, overbite, SNB, ANB, and I to NA (both in mm and degrees). To further validate these findings, additional research with a larger sample size and extended follow-up period is recommended.

Clinical Significance

Present study reveals importance of various parameters in cephalometry, which gives the idea of ideal selection of cases of the twin block and their changes in the patient profile.

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