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DENTOALVEOLAR AND SKELETAL EFFECTS FOLLOWING TREATMENT OF SKELETAL CLASS II MALOCCLUSION WITH TWIN BLOCK APPLIANCE IN HYPERDIVERGENT AND NORMOVERGENT PATIENTS

Original Research

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ABSTRACT

Background: Skeletal Class II malocclusion, often due to mandibular retrusion, is a prevalent orthodontic condition in growing children. Functional appliances such as the Twin Block are widely used for orthopedic correction, yet treatment response varies based on vertical growth patterns. Evaluating the skeletal and dentoalveolar effects of Twin Block therapy in different facial divergence types is essential for individualized treatment planning and optimizing clinical outcomes.

Objective: To evaluate and compare the dentoalveolar and skeletal effects of Twin Block therapy in normodivergent and hyperdivergent patients diagnosed with skeletal Class II malocclusion.

Methods: A quasi-experimental study was conducted at Margalla Institute of Health Sciences, Rawalpindi, over one year. Seventy-three patients aged 10–14 years with CVMI stages 3 or 4, SNB <78°, and permanent dentition up to first molars were selected through consecutive non-probability sampling. Pre- and post-treatment lateral cephalograms were evaluated for sagittal skeletal (SNA, SNB, ANB, Go-Gn), vertical skeletal (MMA, PFH/AFH), and dentoalveolar (U1-SN, L1-MP, U1-L1) parameters. Data were analyzed using SPSS v26, applying paired and independent sample t-tests with significance set at $p \leq 0.05$.

Results: Significant post-treatment improvements were found in SNB (0.9° ± 0.4, p=0.01), ANB (−1.3° ± 0.6, p=0.001), and Go-Gn (1.6 mm ± 0.8, p=0.02). Mandibular plane angle decreased by 0.8° ± 0.6 (p=0.03). Normodivergent patients exhibited superior sagittal improvements in ΔSNB (1.1° ± 0.4) and ΔANB (−1.5° ± 0.5) compared to hyperdivergent patients (p<0.05). Significant dentoalveolar changes included increased L1-MP (2.7° ± 1.3, p=0.001) and decreased U1-L1 (−2.3° ± 1.8, p=0.01), while vertical alveolar height changes were not statistically significant.

Conclusion: Twin Block therapy effectively corrects skeletal Class II malocclusion in growing patients, especially those with normodivergent profiles. However, associated dentoalveolar compensations necessitate careful treatment planning.

Keywords: Cephalometry, Dentoalveolar Processes, Functional Appliances, Malocclusion, Angle Class II, Mandibular Advancement, Orthodontic Appliances.

INTRODUCTION

Malocclusion, a prevalent developmental anomaly, can significantly affect a patient's quality of life by influencing mastication, speech, esthetics, and psychosocial well-being (1). Among various forms, Class II malocclusion is one of the most frequently encountered types worldwide, with substantial geographic and ethnic variation in its prevalence and etiology (2,3). In Pakistan, skeletal Class II malocclusion is notably the most common, with a reported prevalence of 68%, largely attributed to mandibular retrusion rather than maxillary protrusion (4,5). This condition is characterized by an anteroposterior skeletal discrepancy between the maxilla and mandible and is often diagnosed during the developmental stages of craniofacial growth. Early intervention, therefore, is critical for optimizing skeletal correction and minimizing the need for surgical management in adulthood. Functional orthopedic appliances play a pivotal role in the treatment of skeletal Class II malocclusion in growing children by stimulating mandibular growth and repositioning. Among these, the twin block appliance, developed by Dr. William J. Clark, has emerged as a widely accepted modality due to its favorable skeletal outcomes and patient compliance (6). This removable, two-piece acrylic device employs occlusal bite blocks to posture the mandible forward during function, thereby promoting adaptive remodeling of the facial skeleton (7). Its efficacy has been well-documented in clinical studies demonstrating improvements in skeletal parameters such as increased SNB angle, enhanced facial convexity, and greater mandibular corpus length (8,9).

Despite these benefits, twin block therapy is not devoid of limitations. Dental compensations, such as the proclination of mandibular incisors and retroclination of maxillary incisors, are often reported and can undermine the overall orthodontic outcomes (8,9). To address these side effects, several appliance modifications have been proposed, aiming to refine the skeletal changes while minimizing undesirable dental movements (10). In an effort to understand how different vertical growth patterns influence treatment results, a study conducted a comparative analysis of the twin block appliance's effects in normodivergent and hyperdivergent patients. Their findings revealed statistically significant skeletal improvements in the normodivergent group, including increased SNB and decreased ANB angles, whereas dental and vertical skeletal changes remained largely insignificant across both groups (11). While prior literature has explored the general effectiveness of twin block appliances, limited data exist on how facial divergence influences treatment outcomes, particularly within South Asian populations. This gap underscores the need to further investigate the differential response to functional therapy based on growth pattern. Therefore, the objective of this study is to evaluate and compare the skeletal and dentoalveolar effects of the twin block appliance in normodivergent versus hyperdivergent skeletal Class II patients, with the intent to refine treatment planning and improve clinical outcomes.

METHODS

This quasi-experimental study was conducted over a one-year period at the Department of Orthodontics, Margalla Institute of Health Sciences, Rawalpindi, following the approval of the Institutional Ethics Review Committee. A total of 73 participants were included, with the sample size calculated using the WHO sample size calculator, applying a 95% confidence level, population mean of 0.09, standard deviation of 0.39, and absolute precision of 0.09. A non-probability consecutive sampling technique was employed to recruit participants aged between 10 and 14 years, identified as growing patients based on their skeletal maturity assessed via the Cervical Vertebral Maturation Index (CVMI) stages 3 and 4. Additional inclusion criteria required skeletal Class II malocclusion with mandibular retrusion, defined by a SNB angle of less than 78°, and the presence of a complete permanent dentition up to the first molars. Patients with craniofacial anomalies, syndromic conditions, or inadequate radiographic or dental records were excluded to ensure sample homogeneity and data reliability (12). Informed consent was obtained from the parents or legal guardians of all participants prior to inclusion in the study. Patient records were prospectively collected, including standardized lateral cephalograms captured before and after treatment with the twin block appliance. All radiographs were taken with 1:1 magnification to ensure measurement consistency.

Each participant was assigned a serial number to maintain confidentiality, and all identifying information was anonymized. The primary outcome variables included skeletal angular parameters (SNA, SNB, ANB), vertical facial relationships (mandibular-maxillary angle [MMA], posterior facial height to anterior facial height ratio [PFH/AFH]), and dentoalveolar changes (inclination of maxillary and mandibular incisors [U1-SN, L1-MP] and interincisal angle [U1-L1]). Angular measurements were recorded using a protractor, while

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linear values were obtained with a geometric scale, and all assessments were performed manually by a single trained investigator to minimize inter-observer variability. To ensure intra-observer reliability, 10 randomly selected cases were re-measured after an interval of two weeks, and the consistency of repeated measurements was confirmed through comparison. Data were analyzed using IBM SPSS® Statistics version 26.0. Descriptive statistics were applied to summarize qualitative variables in terms of frequencies and percentages, and quantitative variables using means and standard deviations. For within-group comparisons of pre- and post-treatment measurements, paired sample t-tests were applied. Independent sample t-tests were used to assess differences between normodivergent and hyperdivergent skeletal groups. Stratified analyses were conducted by gender, age group, and growth pattern, and post-stratified t-tests were used accordingly. A p-value of ≤0.05 was considered statistically significant.

RESULTS

The study included 73 patients aged 10–14 years with skeletal Class II malocclusion, comprising 52.1% males and 47.9% females. The majority of participants were in the 13–14 years age group (58.9%) and in CVMI stage 3 (61.6%). Based on facial divergence, 54.8% were normodivergent and 45.2% hyperdivergent. Twin Block appliance therapy resulted in statistically significant skeletal and dentoalveolar changes. Post-treatment, a notable increase in the SNB angle was observed (mean difference: 0.9° ± 0.4, *p=0.01*), along with a reduction in ANB angle (−1.3° ± 0.6, *p=0.001*), indicating sagittal skeletal improvement. Mandibular length also significantly increased, as shown by the Go-Gn measurement (1.6 mm ± 0.8, *p=0.02*). Although SNA angle showed a mean decrease of 0.4°, it was not statistically significant (*p=0.12*). Other sagittal parameters, such as AO-BO, also did not show significant change (*p=0.09*). In vertical skeletal dimensions, the mandibular plane angle (MMA) decreased significantly by 0.8° ± 0.6 (*p=0.03*), suggesting a favorable vertical growth pattern. Changes in PFH/AFH ratio, anterior alveolar height, and posterior alveolar height were not statistically significant (*p > 0.05*).

Dentoalveolar evaluation revealed significant proclination of mandibular incisors, with L1-MP increasing by 2.7° ± 1.3 (*p=0.001*), and a reduction in interincisal angle (U1-L1) by 2.3° ± 1.8 (*p=0.01*), indicating retroclination of maxillary incisors. The change in U1-SN angle (−0.6° ± 1.7) was not statistically significant (*p=0.15*). When stratified by facial divergence, normodivergent patients exhibited greater skeletal improvements than hyperdivergent patients. The increase in SNB was higher in the normodivergent group (1.1° ± 0.4) compared to the hyperdivergent group (0.7° ± 0.3), with a statistically significant difference (*p=0.02*). ANB reduction was also more prominent in normodivergent individuals (−1.5° ± 0.5 vs −1.1° ± 0.6, *p=0.04*). The increase in mandibular length (Go-Gn) was greater in normodivergent patients (1.8 mm ± 0.9) than in hyperdivergent ones (1.4 mm ± 0.7), although the difference was not statistically significant (*p=0.10*). Dentoalveolar changes, including mandibular incisor proclination and interincisal angle reduction, were comparable between the two groups, with no statistically significant intergroup differences (*p > 0.05*).

Table 1: Demographic Characteristics of the Study Sample

Variable	Category	Frequency (n=73)	Percentage (%)
Gender	Male	38	52.1%
	Female	35	47.9%
Age (years)	10-12	30	41.1%
	13-14	43	58.9%
CVMI Stage	Stage 3	45	61.6%
	Stage 4	28	38.4%
Facial Divergence	Normodivergent	40	54.8%
	Hyperdivergent	33	45.2%

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Table 2: Comparison of Skeletal and Dentoalveolar Changes Pre- and Post-Treatment (Mean ± SD)

Parameter	Pre-Treatment	Post-Treatment	Mean Difference	p-value
Skeletal (Anteroposterior)				
SNA (°)	82.5 ± 3.2	82.1 ± 3.0	-0.4 ± 0.5	0.12
SNB (°)	75.3 ± 2.8	76.2 ± 2.6	0.9 ± 0.4	**0.01**
ANB (°)	7.2 ± 1.5	5.9 ± 1.3	-1.3 ± 0.6	**0.001**
Go-Gn (mm)	62.4 ± 4.1	64.0 ± 4.3	1.6 ± 0.8	**0.02**
AO-BO (mm)	4.8 ± 1.2	4.5 ± 1.1	-0.3 ± 0.4	0.09
Skeletal (Vertical)				
MMA (°)	28.6 ± 3.4	27.8 ± 3.2	-0.8 ± 0.6	**0.03**
PFH/AFH (%)	62.5 ± 5.0	63.2 ± 4.8	0.7 ± 0.7	0.08
Dentoalveolar				
U1-SN (°)	105.3 ± 6.2	104.7 ± 5.9	-0.6 ± 1.7	0.15
L1-MP (°)	92.4 ± 5.8	95.1 ± 6.0	2.7 ± 1.3	**0.001**
U1-L1 (°)	125.6 ± 7.4	123.3 ± 7.1	-2.3 ± 1.8	**0.01**
Anterior Alveolar Height (mm)	22.3 ± 1.5	22.6 ± 1.4	0.3 ± 0.5	0.06
Posterior Alveolar Height (mm)	18.7 ± 1.2	19.0 ± 1.3	0.3 ± 0.4	0.07

Table 3: Comparison of Treatment Effects Between Normodivergent and Hyperdivergent Groups (Mean ± SD)

Parameter	Normodivergent (n=40)	Hyperdivergent (n=33)	Mean Difference	p-value
Skeletal Changes				
ΔSNB (°)	1.1 ± 0.4	0.7 ± 0.3	0.4 ± 0.2	**0.02**
ΔANB (°)	-1.5 ± 0.5	-1.1 ± 0.6	-0.4 ± 0.3	**0.04**
ΔGo-Gn (mm)	1.8 ± 0.9	1.4 ± 0.7	0.4 ± 0.5	0.10
Dentoalveolar Changes				
ΔL1-MP (°)	2.5 ± 1.2	3.0 ± 1.4	-0.5 ± 0.7	0.08
ΔU1-L1 (°)	-2.1 ± 1.7	-2.5 ± 1.9	0.4 ± 0.9	0.25

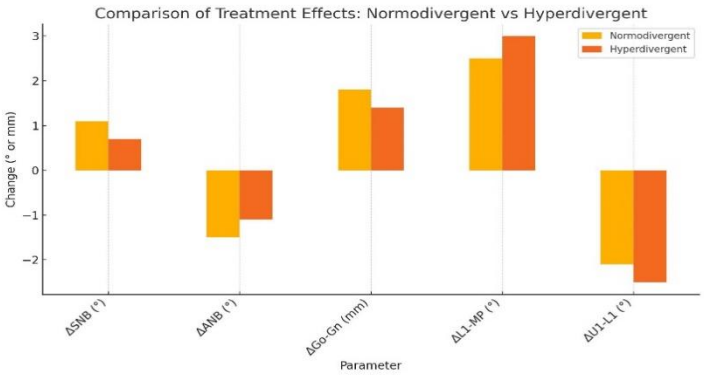

Figure 1 Comparison of Treatment Effects: Normodivergent vs Hyperdivergenty

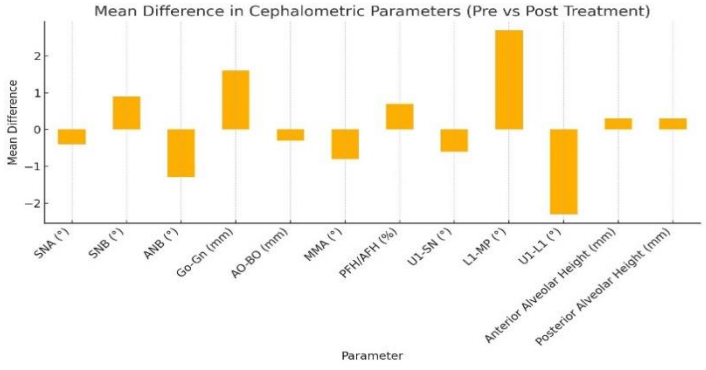

Figure 2 mean Difference in Cephalometric Parameters (pre vs Post Treatments)

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DISCUSSION

The present study demonstrated that Twin Block therapy induced statistically significant skeletal and dentoalveolar changes in growing patients with skeletal Class II malocclusion. Notable improvements were observed in sagittal parameters, particularly the increase in SNB angle, reduction in ANB angle, and lengthening of the mandibular corpus (Go-Gn), indicating effective mandibular advancement ($p < 0.05$). Additionally, vertical skeletal remodeling was evidenced by a significant reduction in the mandibular plane angle, reflecting a favorable counter-clockwise mandibular rotation ($p = 0.03$). These skeletal modifications were accompanied by significant dentoalveolar adaptations, including proclination of the mandibular incisors and retroclination of the maxillary incisors ($p < 0.01$), while changes in alveolar height remained statistically non-significant (13,14). These findings are in agreement with earlier reports that recognized the Twin Block appliance as an effective modality for promoting mandibular growth in Class II cases. Previous studies also documented increased SNB and mandibular length following treatment with Twin Block appliances, although the extent of changes reported elsewhere was greater than those observed in the current investigation (15,16). For example, while the current study found a mean mandibular length increase of 1.6 mm, other investigations reported gains as high as 6.02 mm. Such discrepancies may stem from differences in patient age, skeletal maturity, appliance wear protocols, or follow-up duration (17). The present findings further reinforce the understanding that individual growth patterns significantly influence treatment outcomes. The superior skeletal corrections observed in normodivergent patients compared to hyperdivergent individuals highlight the role of vertical facial morphology in modulating orthopedic responses to functional appliances. This aligns with prior evidence suggesting reduced responsiveness of hyperdivergent cases to sagittal correction (18,19).

A notable strength of the study lies in its focused evaluation of facial divergence as a modifying factor in Twin Block therapy outcomes, an area of clinical interest with implications for case selection and prognosis. The prospective design, standardized radiographic techniques, and intra-observer reliability protocols also contributed to methodological robustness. Moreover, the use of both sagittal and vertical skeletal indicators alongside dentoalveolar parameters ensured a comprehensive appraisal of treatment effects. However, the study was limited by the absence of a control group, which restricts the ability to attribute skeletal changes exclusively to the intervention without accounting for normal growth variations. Additionally, the lack of comparative analysis with other functional appliances, such as the Elastic Activator, limits insight into the relative effectiveness of different treatment modalities. The short-term evaluation of outcomes also precludes assessment of post-treatment stability or long-term retention. Furthermore, soft tissue and airway changes were not evaluated, despite their clinical relevance in growing orthodontic patients undergoing functional therapy (20). Future research should aim to incorporate randomized controlled trials comparing multiple appliances across different growth patterns and age brackets, while integrating soft tissue profile analysis and long-term follow-up. Including three-dimensional imaging and patient-reported outcomes could further enhance the understanding of both skeletal and functional responses to Twin Block therapy.

CONCLUSION

The study concluded that Twin Block appliance therapy is an effective orthopedic intervention for correcting skeletal Class II malocclusion in growing patients, primarily by enhancing mandibular growth and improving sagittal jaw relationships. The therapy yielded more favorable skeletal outcomes in normodivergent individuals, highlighting the influence of vertical growth patterns on treatment response. Although beneficial in advancing mandibular position, the appliance also produced dentoalveolar compensations, emphasizing the need for careful case selection and monitoring. These findings reinforce the clinical utility of Twin Block therapy in early orthodontic intervention and contribute to a more tailored approach in managing different facial growth patterns.

AUTHOR CONTRIBUTION

Author	Contribution
Um e Ayman*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Amjad Mahmood	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Afeef Umar Zia	Substantial Contribution to acquisition and interpretation of Data

Author	Contribution
	Has given Final Approval of the version to be published
Yusra Shaukat	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Farrukh Habib	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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