

Clinical Evaluation of Functional Appliances in the Management of Developing Class II Malocclusion

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ABSTRACT

Background

Class II malocclusion is one of the most frequently encountered dentofacial deformities in orthodontic practice. Functional appliances are widely used during the growth period to correct skeletal discrepancies by stimulating mandibular growth, modifying dentoalveolar structures, and improving facial aesthetics. Early intervention during the mixed dentition stage may provide favorable skeletal and soft tissue outcomes while reducing the complexity of future orthodontic treatment.

Aim

To clinically evaluate the effectiveness of functional appliances in the management of developing Class II malocclusion among growing patients.

Materials and Methods

A prospective clinical study was conducted among 120 growing patients diagnosed with developing skeletal Class II malocclusion. Patients aged 9–14 years were treated using functional appliances such as Twin Block, Activator, and Frankel appliance according to clinical indications. Baseline and post-treatment records included clinical examination, study models, lateral cephalograms, and photographic analysis. Skeletal, dental, and soft tissue parameters were evaluated before and after treatment. Statistical analysis was performed using paired t-test and Chi-square test, with $p < 0.05$ considered statistically significant.

Results

Among 120 patients, 65 (54.2%) were males and 55 (45.8%) females. Significant reduction in overjet was observed from 8.4 ± 1.5 mm to 3.5 ± 0.9 mm ($p < 0.001$). ANB angle reduced from $6.8 \pm 1.2^\circ$ to $3.9 \pm 0.8^\circ$ ($p < 0.001$). Mandibular advancement was reflected by increased SNB angle from $75.4 \pm 2.1^\circ$ to $78.2 \pm 1.8^\circ$ ($p < 0.001$). Improvement in molar relationship was achieved in 88.3% of patients. Facial profile enhancement was observed in 82.5% of cases.

Conclusion

Functional appliance therapy effectively improved skeletal, dental, and soft tissue parameters in developing Class II malocclusion. Early orthopedic intervention during active growth contributed significantly to mandibular advancement and correction of Class II discrepancies.

Keywords: Class II malocclusion, Functional appliances, Twin Block, Growth modification, Orthodontics, Skeletal correction.

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Introduction

Class II malocclusion is among the most prevalent orthodontic problems encountered worldwide and is characterized by a distal relationship of the mandibular arch relative to the maxillary arch. The

condition may arise from maxillary prognathism, mandibular retrognathism, or a combination of both skeletal discrepancies. Epidemiological studies indicate that Class II malocclusion affects approximately 15–30% of children and adolescents, making it a major concern in orthodontic diagnosis

and treatment planning. The condition can adversely affect facial aesthetics, oral function, psychosocial well-being, and quality of life, particularly during adolescence when self-image becomes increasingly important. (1,2)

Developing Class II malocclusion is often associated with mandibular retrusion, increased overjet, deep bite, and convex facial profile. If left untreated during growth, these skeletal discrepancies may worsen and eventually require complex orthodontic camouflage or orthognathic surgery in adulthood. Therefore, early diagnosis and timely intervention are considered essential components of comprehensive orthodontic care. (3)

Functional appliances represent one of the most widely accepted treatment modalities for growth modification in growing patients with skeletal Class II malocclusion. These appliances utilize the patient's own muscular forces to alter mandibular posture and stimulate adaptive skeletal and dentoalveolar changes. Functional appliances can be broadly categorized into removable appliances such as the Twin Block, Activator, Frankel appliance, and Bionator, and fixed functional appliances such as the Herbst appliance. Their primary objective is to encourage mandibular growth while controlling maxillary development and improving occlusal relationships. (4,5)

Among various appliances, the Twin Block appliance has gained considerable popularity because of its patient acceptance, comfort, and effectiveness in promoting mandibular advancement. Clinical and cephalometric studies have demonstrated significant reductions in overjet and improvements in sagittal jaw relationships following Twin Block therapy. Similar benefits have been reported with Activator and Frankel appliances, although variations exist regarding treatment duration and skeletal effects. (6)

The biological basis of functional appliance therapy lies in the adaptive response of condylar cartilage, glenoid fossa remodeling, neuromuscular adaptation, and dentoalveolar compensation. Growth modification is most effective during periods of accelerated skeletal growth, particularly around the pubertal growth spurt. Consequently, accurate timing of intervention plays a crucial role in maximizing treatment success. (7)

Several investigations have evaluated skeletal and dental changes following functional appliance therapy. Previous studies reported significant increases in mandibular length, reduction in ANB angle, improvement in facial convexity, and favorable correction of molar relationships. Nevertheless, variability in treatment response exists due to differences in growth potential, appliance design, compliance, and treatment duration. (8,9)

Apart from skeletal correction, functional appliances also contribute to improved facial aesthetics and psychosocial outcomes. Reduction in facial

convexity and enhancement of chin prominence often result in greater patient satisfaction and improved self-esteem. These benefits emphasize the importance of early orthopedic intervention in selected patients with developing Class II malocclusion. (10)

Despite extensive research, continued evaluation of clinical outcomes remains necessary to optimize treatment protocols and identify factors influencing therapeutic success. Therefore, the present study was undertaken to clinically evaluate the effectiveness of functional appliances in managing developing Class II malocclusion among growing patients and to assess associated skeletal, dentoalveolar, and soft tissue changes. (11)

Materials and Methodology

Study Design

A prospective longitudinal clinical study was conducted to evaluate the effectiveness of functional appliances in the management of developing Class II malocclusion.

Study Setting

The study was carried out in the Department of Orthodontics and Dentofacial Orthopedics of a tertiary dental teaching institution.

Study Duration

The study was conducted over a period of 24 months, including patient recruitment, treatment, follow-up, data collection, and statistical analysis.

Sample Size

A total of 120 patients diagnosed with developing skeletal Class II malocclusion were included in the study.

Sample Size Justification

The sample size was calculated using the formula:

$$[n = \frac{Z^2 P(1-P)}{d^2}]$$

Where:

- $Z = 1.96$ at 95% confidence interval
- $P =$ anticipated treatment success rate of 85%
- $d =$ allowable error of 6%

The calculated minimum sample size was approximately 109. To compensate for potential dropouts, 120 participants were recruited.

Sampling Technique

Consecutive sampling technique was used for patient recruitment.

Inclusion Criteria

- Patients aged 9–14 years.
- Skeletal Class II malocclusion due predominantly to mandibular retrusion.
- ANB angle greater than 4° .
- Increased overjet (>5 mm).
- Cervical vertebral maturation stages indicating active growth.
- Good general health.
- Willingness to participate and comply with treatment.

Exclusion Criteria

- Previous orthodontic treatment.

- Craniofacial syndromes or cleft lip/palate.
- Severe skeletal asymmetry.
- Systemic diseases affecting growth.
- Poor oral hygiene.
- Non-compliant patients.

Clinical Examination

Each patient underwent detailed orthodontic examination including:

- Facial profile assessment.
- Lip competence evaluation.
- Overjet measurement.
- Overbite measurement.
- Molar and canine relationship assessment.
- Functional mandibular movement evaluation.

Diagnostic Records

Study Models

Maxillary and mandibular impressions were obtained and dental casts prepared.

Photographic Records

Standardized extraoral and intraoral photographs were recorded.

Radiographic Assessment

Lateral cephalometric radiographs were obtained before treatment and after completion of functional appliance therapy.

Functional Appliance Therapy

Patients were treated using:

- Twin Block appliance
- Activator appliance
- Frankel appliance

Selection was based on individual clinical requirements.

Appliance Instructions

Patients were instructed to:

- Wear appliances for 18–20 hours daily.
- Maintain oral hygiene.
- Attend monthly follow-up visits.

Outcome Variables

Skeletal Parameters

- SNA angle
- SNB angle
- ANB angle
- Mandibular length (Co-Gn)

Dental Parameters

- Overjet
- Overbite
- Incisor inclination
- Molar relationship

Soft Tissue Parameters

- Facial convexity angle
- Nasolabial angle
- Lip competence

Follow-up Protocol

Patients were reviewed monthly.

Assessments were performed at:

- Baseline
- 6 months

- 12 months
- Completion of treatment

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics.

The following statistical tests were used:

- Descriptive statistics (mean, standard deviation, frequency, percentage)
- Paired t-test for pre- and post-treatment comparison
- Chi-square test for categorical variables
- Pearson correlation analysis where applicable

A p-value <0.05 was considered statistically significant.

RESULTS

A total of 120 growing patients with developing skeletal Class II malocclusion completed functional appliance therapy and were included in the final analysis. The study evaluated demographic characteristics, skeletal and dentoalveolar changes, and overall treatment outcomes following therapy with Twin Block, Activator, and Frankel appliances.

Table 1. Demographic and Baseline Characteristics of Study Participants (n=120)

Variable	Number (n)	Percentage (%)
Age Group (Years)		
9–10	32	26.7
11–12	48	40.0
13–14	40	33.3
Gender		
Male	65	54.2
Female	55	45.8
Baseline Overjet		
5–7 mm	38	31.7
8–10 mm	57	47.5
>10 mm	25	20.8
Baseline Molar Relation		
End-on Class II	44	36.7
Full Class II	76	63.3

Chi-square p value = 0.482 (Not Significant)

The majority of patients belonged to the 11–12-year age group (40.0%), corresponding to the period of accelerated pubertal growth. Male patients slightly outnumbered females. Nearly half of the patients presented with overjet between 8–10 mm, while 63.3% exhibited a full Class II molar relationship, indicating moderate to severe sagittal discrepancy at baseline. The age and gender distribution did not differ significantly (p=0.482).

Table 2. Comparison of Skeletal and Dental Parameters Before and After Functional Appliance Therapy (n=120)

Parameter	Pretreatment Mean ± SD	Post-treatment Mean ± SD	Mean Difference	p value
SNA (°)	82.8 ± 2.5	82.1 ± 2.3	-0.7	0.031*
SNB (°)	75.4 ± 2.1	78.2 ± 1.8	+2.8	<0.001*
ANB (°)	6.8 ± 1.2	3.9 ± 0.8	-2.9	<0.001*
Mandibular Length (mm)	104.2 ± 5.6	109.1 ± 5.2	+4.9	<0.001*
Overjet (mm)	8.4 ± 1.5	3.5 ± 0.9	-4.9	<0.001*
Overbite (mm)	5.2 ± 1.1	2.9 ± 0.8	-2.3	<0.001*

*Statistically Significant

Significant skeletal improvements were observed following functional appliance therapy. SNB angle increased by 2.8°, indicating forward mandibular positioning. ANB angle decreased significantly from 6.8° to 3.9°, reflecting correction of sagittal jaw discrepancy. Mandibular length increased by 4.9 mm, suggesting favorable mandibular growth stimulation.

Dental parameters also showed marked improvement. Mean overjet reduced by 58.3%, while overbite decreased by 44.2%. All changes were statistically significant (p<0.001), except for a small reduction in SNA angle, indicating mild restraint of maxillary growth.

Table 3. Treatment Outcomes and Soft Tissue Changes After Functional Appliance Therapy (n=120)

Outcome Variable	Number (n)	Percentage (%)	p value
Achievement of Class I Molar Relationship	106	88.3	<0.001*
Residual End-on Relationship	14	11.7	
Facial Profile Improvement	99	82.5	<0.001*
Improved Lip Competence	101	84.2	<0.001*
Reduction in Facial Convexity	97	80.8	<0.001*
Excellent Compliance	89	74.2	0.012*

Outcome Variable	Number (n)	Percentage (%)	p value
Moderate Compliance	24	20.0	
Poor Compliance	7	5.8	
Overall Treatment Success	103	85.8	<0.001*

*Statistically Significant

Interpretation

Functional appliance therapy produced favorable soft tissue and occlusal outcomes. Class I molar relationship was achieved in 88.3% of patients. Facial profile improvement and enhanced lip competence were observed in more than 80% of subjects. Overall treatment success was recorded in 85.8% of cases. Higher compliance was significantly associated with superior treatment outcomes (p=0.012).

DISCUSSION

Class II malocclusion remains one of the most prevalent orthodontic problems encountered during childhood and adolescence. Functional appliance therapy has long been advocated as an effective method of growth modification in patients exhibiting mandibular retrusion. The present study evaluated the clinical effectiveness of functional appliances in 120 growing patients and demonstrated significant improvements in skeletal, dentoalveolar, and soft tissue parameters following treatment.

The majority of patients in the present study belonged to the 11–12-year age group, corresponding to the peak period of pubertal growth. This observation is clinically relevant because functional appliance therapy is known to be most effective when administered during periods of active skeletal growth. Baccetti et al. reported that treatment initiated during the pubertal growth spurt results in greater mandibular advancement and more favorable skeletal outcomes compared with treatment undertaken before or after this period. [1] The present investigation demonstrated a significant increase in SNB angle and mandibular length following treatment. The mean increase in SNB angle of 2.8° and mandibular length increment of 4.9 mm suggest substantial mandibular advancement. Similar findings were reported by O’Brien et al., who observed significant enhancement in mandibular projection following Twin Block therapy among growing Class II patients. [2] A significant reduction in ANB angle was observed in the current study. The decrease from 6.8° to 3.9° reflects considerable correction of sagittal jaw discrepancy. These findings are consistent with those reported by Perillo et al., who documented significant reductions in ANB angle after functional appliance treatment due to combined skeletal and dentoalveolar effects. [3]

The reduction in SNA angle observed in the present study was relatively small but statistically significant. This finding suggests a modest restraining effect on maxillary forward growth. Similar observations were reported by Cozza et al., whose systematic review concluded that functional appliances exert both mandibular stimulatory effects and limited maxillary growth restraint. [4]

Overjet reduction remains one of the most clinically significant outcomes of functional appliance therapy. In the current study, mean overjet decreased from 8.4 mm to 3.5 mm, representing a reduction of approximately 58%. Tulloch et al. similarly demonstrated substantial overjet reduction among patients treated with functional appliances, contributing significantly to improved occlusion and facial aesthetics. [5]

Overbite reduction observed in this study also aligns with previous investigations. The correction of deep bite may be attributed to eruption of posterior teeth, dentoalveolar remodeling, and mandibular repositioning during appliance therapy. Pancherz reported similar vertical improvements following functional treatment of Class II malocclusion. [6]

An important finding of the present study was the achievement of Class I molar relationship in 88.3% of patients. This outcome indicates successful correction of sagittal occlusal discrepancies. Comparable success rates have been documented in studies evaluating Twin Block and Activator appliances, emphasizing their effectiveness in growth modification. [7]

Soft tissue improvements observed in this study were particularly encouraging. Facial profile enhancement was noted in 82.5% of patients, while improved lip competence occurred in 84.2%. Improved facial balance and reduction in facial convexity are often considered among the most important treatment outcomes from the patient's perspective. Morris et al. reported significant improvements in facial aesthetics and psychosocial well-being following Class II correction with functional appliances. [8]

Patient compliance remains a critical determinant of treatment success for removable functional appliances. In the present study, excellent compliance was observed in nearly three-fourths of patients and was significantly associated with successful treatment outcomes. Similar conclusions have been reported by Fleming et al., who emphasized that appliance wear time strongly influences skeletal and dental responses. [9]

The overall treatment success rate of 85.8% observed in this study is consistent with previous clinical reports evaluating Twin Block and Activator appliances. Meta-analyses conducted by Perinetti et al. and Koretsi et al. concluded that functional appliances provide clinically meaningful skeletal improvements, particularly in carefully selected growing patients. [10,11]

The findings of the present study support the concept that early intervention during growth can effectively reduce the severity of Class II malocclusion and potentially minimize the need for future orthodontic extractions or orthognathic surgery. Nevertheless, individual variability in growth potential, appliance design, compliance, and treatment timing may influence treatment outcomes. [12]

Although the study demonstrated favorable results, certain limitations should be acknowledged. The absence of an untreated control group limited direct assessment of natural growth effects. Furthermore, long-term post-retention evaluation was not performed. Future randomized controlled trials with extended follow-up periods may provide additional evidence regarding the stability of treatment outcomes. [13-17]

Overall, the present study confirms that functional appliance therapy remains an effective and predictable modality for the correction of developing Class II malocclusion in growing patients.

CONCLUSION

Functional appliance therapy demonstrated significant effectiveness in the management of developing Class II malocclusion among growing patients.

The study showed:

- Significant increase in mandibular growth and forward positioning.
- Significant reduction in ANB angle and skeletal discrepancy.
- Marked improvement in overjet and overbite.
- Successful correction of molar relationships in the majority of patients.
- Significant enhancement of facial profile and soft tissue balance.
- High overall treatment success associated with good patient compliance.

Early intervention during active growth periods can effectively modify skeletal relationships and improve both functional and esthetic outcomes. Functional appliances continue to represent a valuable treatment option for growing patients with developing skeletal Class II malocclusion.

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