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Case Report

Comparative Evaluation of a Clear Functional Jaw Corrector and a Conventional Twin Block Appliance in Monozygotic Twins with Skeletal Class II Malocclusion: A Case Report

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Abstract

Functional appliance therapy is widely employed for the management of skeletal Class II malocclusion in growing patients. However, treatment outcomes are influenced by multiple biological and behavioural variables, including genetic background, craniofacial growth pattern, neuromuscular adaptability, and patient compliance. These factors often limit the ability to directly compare the effectiveness of different appliance systems in routine clinical studies. Monozygotic twin investigations provide a valuable biological model by minimizing genetic and environmental variability, thereby enabling a more accurate assessment of appliance related effects. This case report presents a comparative evaluation of a clear functional jaw corrector and a conventional twin block appliance in monozygotic twin patients presenting with similar skeletal and dental Class II malocclusion. Two 11-year-old female monozygotic twins at cervical vertebral maturation index stage 3 exhibited comparable skeletal Class II patterns, vertical growth tendencies, proclined maxillary incisors and convex soft tissue profiles. Twin A was treated using a removable clear functional jaw corrector fabricated by incorporating mandibular advancement blocks into a 1.5-mm Essix retainer sheet, whereas Twin B was treated using a conventional twin block appliance. Treatment objectives, appliance wear protocol, and treatment duration were identical for both patients. Post-treatment clinical and cephalometric evaluation demonstrated improvement in sagittal jaw relationships, facial profile, and occlusal relationships in both twins. However, differences were observed in the magnitude of skeletal correction, dentoalveolar changes, vertical control, and molar and canine relationship correction. The findings emphasize appliance specific effects under near identical biological conditions and support the scientific relevance of monozygotic twin comparisons in functional appliance research.

Keywords: monozygotic twins; functional appliances; Class II malocclusion; twin block; clear functional appliance; growth modification

1. Introduction

Class II malocclusion represents one of the most prevalent orthodontic problems encountered in clinical practice and constitutes a significant proportion of orthodontic treatment demand worldwide. Epidemiological studies have demonstrated that mandibular retrognathism represents the predominant skeletal component in a majority of Class II cases [1]. This sagittal discrepancy is frequently associated with increased overjet, compromised facial esthetics, lip incompetence, and functional imbalance, which may negatively affect both oral health and psychosocial well-being.

Early orthopedic intervention during the growth phase has been widely advocated for patients presenting with skeletal Class II malocclusion. Functional appliance therapy aims to modify unfavorable growth patterns, improve sagittal jaw relationships, and enhance facial harmony by

positioning the mandible in an advanced functional position [2]. When instituted at an appropriate stage of skeletal maturation, such therapy may reduce the severity of malocclusion, facilitate subsequent fixed appliance treatment, and improve long-term treatment stability.

Despite extensive clinical use over several decades, the biological mechanisms and clinical effectiveness of functional appliances remain subjects of ongoing debate. Numerous studies have reported variable outcomes with respect to skeletal modification, dentoalveolar adaptation, and soft tissue changes [3]. While some investigations have suggested significant mandibular growth stimulation, others have emphasized the predominance of dentoalveolar compensation. This inconsistency has contributed to uncertainty regarding the predictability and long-term stability of functional appliance therapy.

Individual variability in treatment response represents one of the principal challenges in evaluating functional appliances. Differences in growth potential, vertical growth pattern, genetic predisposition, neuromuscular adaptation, and patient compliance have all been identified as critical determinants of treatment outcome [4]. These biological and behavioral factors frequently confound comparisons between different appliance systems in routine clinical studies, thereby limiting the strength of available evidence.

Twin studies, particularly those involving monozygotic twins, provide a powerful methodological approach for controlling genetic variability and minimizing environmental influences [5]. Monozygotic twins share identical genetic material and typically exhibit highly similar craniofacial growth patterns, dental development, and muscular characteristics. When treated at the same chronological age and growth stage, such twins offer a natural biological control model in which differences in treatment outcomes may be more confidently attributed to appliance-related factors rather than inherent biological variation.

The twin block appliance, introduced by Clark, remains one of the most extensively studied and widely accepted removable functional appliances for the management of skeletal Class II malocclusion [6]. Its popularity stems from its relative simplicity, patient acceptability, and demonstrated clinical effectiveness. Several investigations have documented its ability to produce combined skeletal and dentoalveolar changes, particularly when used during periods of active growth [7].

In recent years, advances in material science and appliance design have led to the development of clear functional appliances aimed at improving esthetics, reducing appliance bulk, and enhancing patient acceptance. These appliances attempt to replicate the orthopedic and dental effects of conventional designs while offering improved appearance and comfort. Improved esthetics may be particularly important for adolescent patients, in whom social acceptance and self-image play important roles in treatment compliance.

Although several clinical studies have compared conventional and modified twin block appliances [8,9], high-quality evidence evaluating clear functional appliances under genetically controlled conditions remains limited. Most available investigations involve heterogeneous patient samples, thereby limiting the ability to isolate appliance-specific effects. Furthermore, long-term data comparing esthetic and conventional designs remain scarce.

The present case report was therefore undertaken to compare the clinical and cephalometric effects of a clear functional jaw corrector and a conventional twin block appliance in monozygotic twins presenting with similar skeletal and dental Class II malocclusion during the active growth phase. By utilizing a genetically controlled model, this study aims to provide more reliable insight into appliance-related treatment effects and contribute to evidence-based clinical decision-making.

Study Rationale

The scientific rationale for the present investigation is based on the recognition that genetic and growth-related variability represents a major limitation in orthodontic research. Even well-designed randomized clinical trials may be influenced by individual differences in growth pattern and

biological response. Monozygotic twin studies offer a rare opportunity to overcome these limitations by providing a biologically matched comparison.

Furthermore, increasing patient demand for esthetic treatment options has led to growing interest in clear functional appliances. However, clinicians require robust scientific evidence regarding their effectiveness relative to conventional designs. The present report seeks to address this knowledge gap by evaluating two appliances under controlled biological conditions.

2. Case Report

Patient Information and Initial Examination

Two 11-year-old female monozygotic twins reported to the orthodontic clinic with the primary concern of forwardly placed upper front teeth and an unaesthetic facial appearance. Both patients and their parents expressed dissatisfaction with the facial profile and dental protrusion, particularly during smiling. The patients were in good general health, and medical history was non-contributory. No history of systemic disease, craniofacial trauma, parafunctional habits, or previous orthodontic treatment was reported.

Clinical evaluation and radiographic assessment revealed that both patients were in cervical vertebral maturation index (CVMI) stage 3, indicating the onset of the pubertal growth spurt. This stage has been widely recognized as an optimal period for functional appliance therapy aimed at modifying sagittal jaw relationships [3,4]. The identical chronological age and skeletal maturation of the twins further strengthened the biological comparability of the cases.

Extraoral examination revealed a convex facial profile with a retrusive mandibular appearance in both patients (Figure 1). The lower facial height appeared increased, and both patients exhibited mild lip incompetence at rest. Smile analysis demonstrated increased maxillary incisor display and reduced chin projection. No facial asymmetry was noted, and the temporomandibular joints were asymptomatic.



Figure 1. Pre-treatment extraoral photographs. Extraoral examination revealed a convex facial profile with a retrognathic mandibular appearance in both patients.

Diagnosis

Skeletal Diagnosis

Cephalometric analysis revealed skeletal Class II malocclusion in both patients, characterized by an ANB angle of 8° and a retrognathic mandible. The SNA angle was 78° in both twins, while the SNB angle measured 70°, confirming a sagittal discrepancy primarily related to mandibular retrusion. Both patients exhibited a vertical growth pattern, as indicated by increased mandibular plane angles and SN–GoGn values.

Twin A demonstrated a slightly greater vertical component compared to Twin B, a finding of clinical relevance given the known influence of vertical growth tendencies on functional appliance response [4,7]. Vertical growers have been reported to exhibit less favorable skeletal response and greater dentoalveolar compensation during functional therapy, emphasizing the importance of appliance design and vertical control.

Dental Diagnosis

Intraoral examination revealed similar dental characteristics in both patients (Figure 2). Mild crowding was present in both the maxillary and mandibular arches. Bilateral Class II molar and canine relationships were observed, with an increased overjet due to proclination of the maxillary incisors. The mandibular incisors were mildly proclined in both patients.

The dental midlines coincided with the facial midline, and no transverse discrepancies or posterior crossbites were detected. The occlusal planes were symmetrical, and no significant rotations or spacing were present.



Figure 2. Pre-treatment intraoral photographs. Intraoral examination demonstrated bilateral Class II molar and canine relationships with proclined maxillary incisors in both twins.

Soft Tissue Diagnosis

Soft tissue evaluation demonstrated a convex facial profile with reduced chin prominence in both patients. The nasolabial angle was mildly reduced, and lip competence was compromised at rest. The soft tissue findings were consistent with the underlying skeletal Class II pattern and contributed significantly to the patients’ esthetic concerns. (Figure 1)

Treatment Objectives

The treatment objectives for both patients were identical:

- 1. Correction of skeletal Class II jaw relationship
- 2. Advancement of the mandible during the growth phase
- 3. Control of maxillary incisor proclination
- 4. Improvement of facial profile and soft tissue harmony
- 5. Achievement of bilateral Class I molar and canine relationships
- 6. Establishment of functional occlusal relationships

Treatment Plan

To enable a controlled comparison, both patients were treated using functional appliances designed to advance the mandible, with the primary difference being appliance design.

Twin A: Clear Functional Jaw Corrector

Twin A was treated using a removable clear functional jaw corrector (CFJC). Mandibular advancement blocks were fabricated on dental casts, and a 1.5-mm Essix retainer sheet was vacuum-formed over the blocks. The resulting appliance provided full dental coverage and incorporated inclined planes analogous to those of a conventional twin block appliance.

The mandible was advanced to an edge-to-edge incisal relationship at the time of appliance insertion. No incremental advancement protocol was employed, as both patients demonstrated adequate tolerance to the initial advancement. The transparent design was intended to improve esthetics, reduce appliance visibility, and enhance patient acceptance. (Figure 3)

**Twin A was given the
Clear Functional Jaw Corrector**



**Twin B was given the
Twin Block Appliance**





Figure 3. Appliances used. The clear functional jaw corrector used for Twin A and the conventional twin block appliance used for Twin B are shown.

Twin B: Conventional Twin Block Appliance

Twin B was treated using a conventional twin block appliance fabricated with acrylic bite blocks and interlocking inclined planes following established clinical protocols [6]. The appliance was designed to posture the mandible forward and facilitate sagittal correction through orthopedic and dentoalveolar mechanisms.

The amount of mandibular advancement was standardized to match that used in Twin A to ensure comparable functional positioning.

Treatment Progress

Both patients were instructed to wear their respective appliances for a minimum of 15 hours per day, including nighttime and daytime use. Oral hygiene instructions and appliance maintenance guidelines were provided.

Follow-up visits were scheduled at four-week intervals to monitor appliance fit, compliance, and treatment progress. Both patients demonstrated good cooperation throughout the treatment period, as confirmed through clinical evaluation and patient feedback. No appliance breakage, soft tissue irritation, or adverse effects were observed.

The total duration of functional appliance therapy was 10 months for both twins.

3. Results

Clinical Evaluation

Twin A

Post-treatment examination revealed correction of bilateral molar and canine relationships to Class I. A marked improvement in facial profile was observed, characterized by reduced convexity and enhanced mandibular projection (Figure 4). Lip competence improved, and facial balance was enhanced.



Figure 4. Post-treatment intraoral and extraoral photographs (Twin A). Post-treatment intraoral evaluation of Twin A revealed correction to bilateral Class I molar and canine relationships and extraoral photographs showed improvement in profile.

Twin B

Post-treatment evaluation demonstrated correction of molar relationship to Class I; however, the canine relationship remained Class II bilaterally. Facial profile improvement was evident but was less pronounced compared to Twin A (Figure 5).



Figure 5. Post-treatment intraoral photographs (Twin B).

In Twin B, post-treatment intraoral findings demonstrated correction to Class I molar relationship with persistence of Class II canine relationship and extraoral photographs showed some improvement in profile.

Cephalometric Evaluation-

Cephalometric analysis revealed significant changes in sagittal, dental, and vertical parameters in both patients.

Twin A

Twin A exhibited a reduction in ANB angle from 8° to 4°, primarily due to a decrease in SNA angle, suggesting a restraining effect on maxillary growth. The SNB angle remained unchanged, indicating limited true mandibular advancement. Vertical parameters remained relatively stable, reflecting effective vertical control (Table 1).

Table 1. Clear Functional Jaw Corrector.

Parameter	Pre-treatment	Post-treatment
SNA (°)	78	74
SNB (°)	70	70
ANB (°)	8	4
U1–NA (°/mm)	30° / 6 mm	30° / 6.5 mm
L1–NB (°/mm)	27° / 6 mm	32° / 7.5 mm
FMA (°)	27	27
SN–GoGn (°)	33	32
Witts appraisal	AO 5.5mm ahead of BO	AO 5mm ahead of BO
L1- Apog	+1mm	+5mm
U1-SN	110	103
IMPA	100	102
Go-Pog	55mm	60mm
Co-Gn	91mm	91mm
N perpendicular to Pog	-20mm	-16mm

Cephalometric superimposition demonstrated improvement in sagittal jaw relationship with favorable dental positioning and minimal vertical opening (Figures 6 and 8).

Twin B

Twin B demonstrated a slight reduction in ANB angle from 8° to 7°. Greater proclination of both maxillary and mandibular incisors was observed, indicating increased dentoalveolar compensation. Vertical parameters increased, suggesting vertical opening during treatment (Table 2).

Cephalometric superimposition illustrated predominantly dentoalveolar changes with limited skeletal correction (Figures 7 and 9).

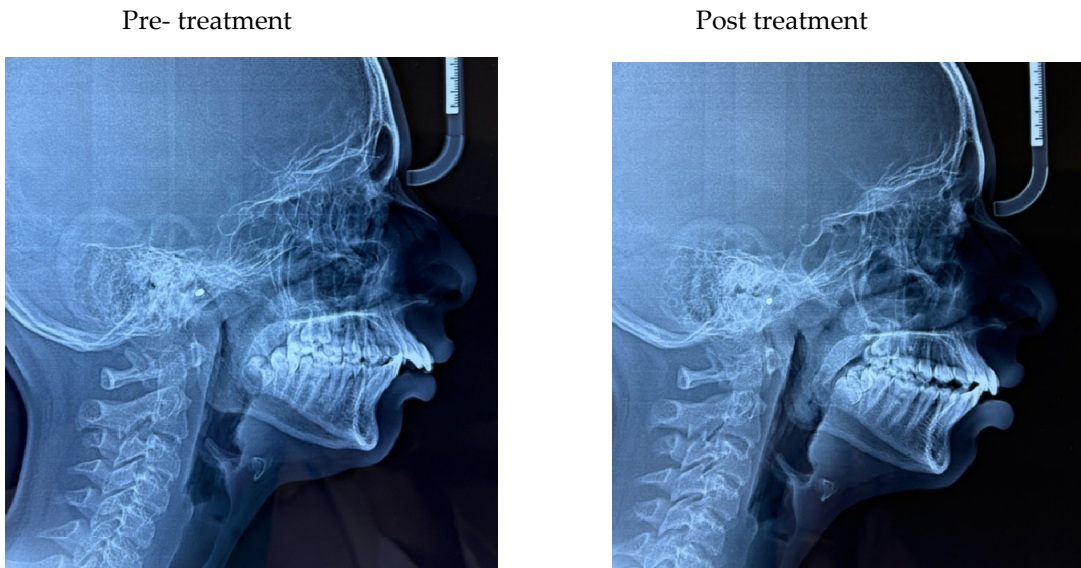


Figure 6. Pre- and post-treatment lateral cephalograms of Twin A illustrating changes in sagittal jaw relationship following treatment with the clear functional jaw corrector.

Table 2. Conventional Twin Block.

Parameter	Pre-treatment	Post-treatment
SNA (°)	78	77
SNB (°)	70	70
ANB (°)	8	7
U1-NA (°/mm)	37° / 9 mm	38° / 10 mm
L1-NB (°/mm)	30° / 6 mm	37° / 8 mm
FMA (°)	29	32
SN-GoGn (°)	37	39
Witts appraisal	AO 7mm ahead of BO	AO 6mm ahead of BO
L1- Apog	-3mm	-4mm
U1-SN	113	102
IMPA	77	108
Go-Pog	58mm	61mm
Co-Gn	86mm	91mm
N perpendicular to Pog	-19mm	-18mm

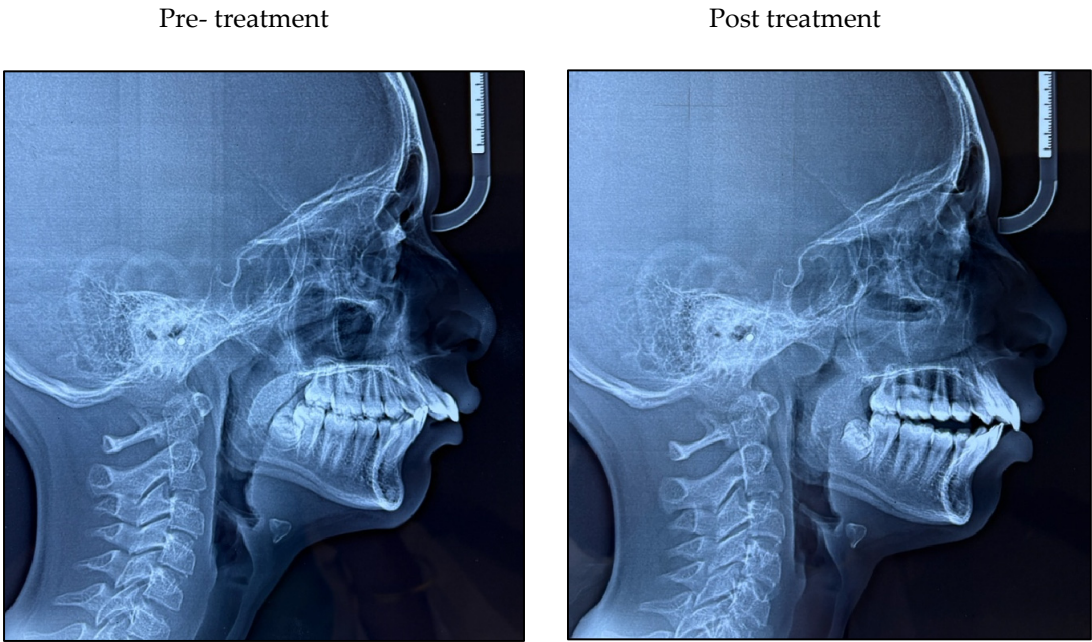


Figure 7. Pre- and post-treatment lateral cephalograms of Twin B demonstrating skeletal and dentoalveolar changes following treatment with the conventional twin block appliance.

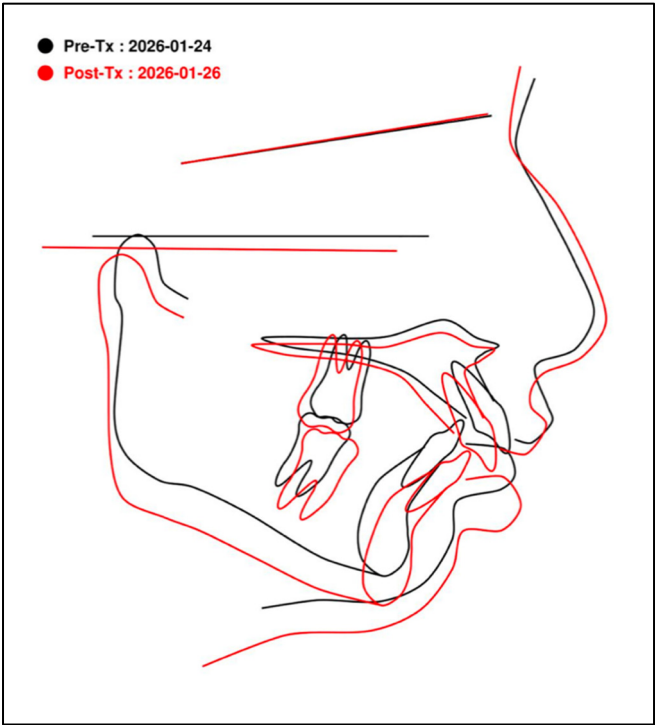


Figure 8. Cephalometric tracings (Twin A).

Superimposition of pre- and post-treatment cephalometric tracings for Twin A demonstrated improvement in sagittal jaw relationship

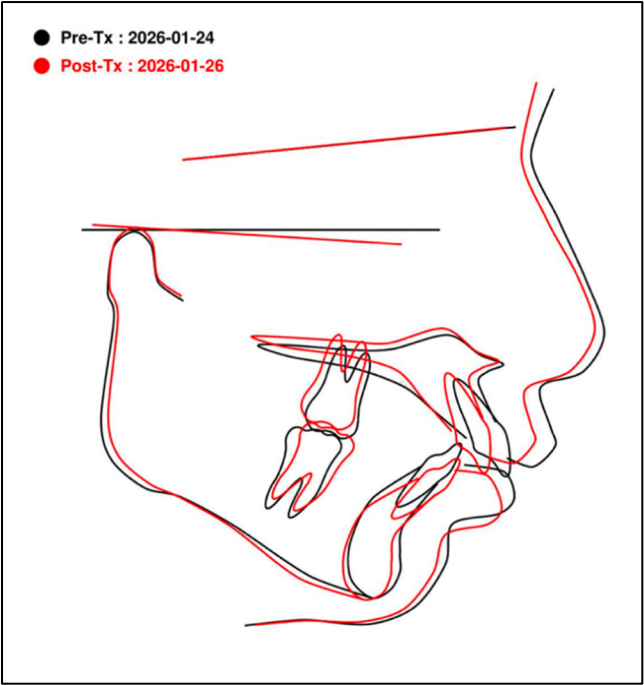


Figure 9. Cephalometric tracings (Twin B).

Cephalometric superimposition for Twin B illustrated dentoalveolar changes following functional appliance therapy

Comparative Summary of Results

Although both appliances produced improvement in sagittal jaw relationships, the magnitude and nature of changes differed between the twins. The clear functional jaw corrector demonstrated better sagittal correction, improved vertical control, and complete molar and canine correction. In contrast, the conventional twin block appliance exhibited greater dentoalveolar effects and incomplete canine correction.

4. Discussion

The present monozygotic twin case report was designed to evaluate and compare the effects of two different functional appliance systems under near-identical biological conditions. In orthodontic research, direct comparison of treatment modalities is frequently complicated by substantial inter-individual variability in growth potential, craniofacial morphology, neuromuscular adaptability, and patient compliance. These confounding variables often obscure appliance-specific effects and contribute to inconsistent or contradictory findings in the literature. By utilizing monozygotic twins of identical age, sex, skeletal maturation stage, and malocclusion characteristics, the present study minimizes genetic and environmental variability and allows a more reliable interpretation of treatment-related differences.

Functional appliance therapy has long been advocated for the management of skeletal Class II malocclusion during the growth phase, particularly in patients with mandibular retrusion [1,2]. The biological principle underlying such therapy is based on altering mandibular posture to stimulate adaptive changes in skeletal structures, musculature, and dentoalveolar components. However, the extent to which these adaptive changes result in permanent skeletal modification remains controversial. Numerous investigations have demonstrated that the therapeutic response to functional appliances is highly variable and influenced by individual biological characteristics [3,4].

The twin block appliance, introduced by Clark, has become one of the most widely accepted removable functional appliances due to its relative simplicity, patient acceptability, and proven clinical effectiveness [6]. Several studies have documented its ability to produce improvement in sagittal jaw relationships through a combination of skeletal and dental mechanisms [7]. Mills and McCulloch [7] reported that twin block therapy primarily results in dentoalveolar adaptations accompanied by modest skeletal changes. These findings have been corroborated by subsequent investigations and reviews [8,9], which emphasized that appliance design, timing of treatment, and growth pattern play crucial roles in determining treatment outcome.

In the present study, both twins exhibited improvement in sagittal jaw relationships following functional appliance therapy. However, the magnitude and nature of changes differed between the two patients. Twin A, treated with the clear functional jaw corrector, demonstrated greater reduction in ANB angle, improved vertical control, and complete correction of molar and canine relationships. In contrast, Twin B, treated with the conventional twin block appliance, exhibited limited skeletal improvement, greater dentoalveolar compensation, and incomplete canine correction. These findings suggest that appliance design may influence the balance between skeletal and dental effects, even when biological variables are controlled.

The systematic review and meta-analysis by Mani et al. [10] concluded that both clear and conventional twin block appliances are capable of producing clinically meaningful correction of Class II malocclusion. However, the authors also highlighted considerable heterogeneity among studies, particularly with respect to dentoalveolar effects and vertical changes. The present report reflects this heterogeneity at an individual level, demonstrating differential responses in two genetically identical patients treated with different appliances.

One of the most noteworthy observations in Twin A was the greater reduction in ANB angle achieved primarily through a decrease in SNA rather than an increase in SNB. This finding suggests a restraining effect on maxillary growth rather than true mandibular length increase. Previous investigations have reported similar patterns, indicating that functional appliances frequently

achieve sagittal correction through maxillary restraint and dentoalveolar adaptation rather than significant mandibular growth stimulation [7,17]. Perinetti et al. [17] emphasized that removable functional appliances produce limited mandibular growth and that much of the observed correction is attributable to positional and dental changes.

Twin B exhibited greater proclination of both maxillary and mandibular incisors, indicating increased dentoalveolar compensation. Such compensation may facilitate short-term sagittal correction but has been associated with compromised long-term stability and less favorable esthetic outcomes [19]. Wu et al. [18] reported similar findings in patients treated with mandibular advancement using clear aligners, where dental movements contributed substantially to correction. Excessive incisor proclination may also increase susceptibility to periodontal complications and relapse, underscoring the importance of careful incisor control during functional therapy.

Vertical growth control represents a critical factor in the management of Class II malocclusion, particularly in patients with vertical growth tendencies. Both twins in the present study exhibited a vertical growth pattern at baseline. Twin A demonstrated better vertical stability following treatment, whereas Twin B exhibited increased mandibular plane angles. Increased vertical opening during functional appliance therapy has been associated with reduced sagittal correction and increased dental compensation [7,12]. The full-coverage design and occlusal characteristics of the clear functional appliance may have contributed to improved vertical control in Twin A by limiting posterior tooth eruption and maintaining favorable mandibular rotation.

Neuromuscular adaptation plays an important role in the response to functional appliance therapy. By positioning the mandible forward, functional appliances alter muscle activity patterns and temporomandibular joint loading. Adaptive remodeling of these structures may contribute to treatment stability. However, individual variability in neuromuscular response may influence treatment outcome. Differences in muscular adaptability between patients may partially explain variability in skeletal response observed in functional appliance therapy [3,4]. Although neuromuscular parameters were not directly assessed in the present study, their potential influence should be acknowledged.

Patient compliance remains one of the most critical determinants of success in removable functional appliance therapy. Although both twins demonstrated comparable compliance based on clinical assessment and parental reports, subtle differences in wear patterns may have influenced treatment outcomes. Doll et al. [20] demonstrated a strong association between patient discomfort, appliance acceptance, and compliance. Appliances that are bulky, uncomfortable, or socially conspicuous may reduce wear time, particularly in adolescent patients. The transparent design and reduced bulk of the clear functional appliance may therefore represent a clinically relevant advantage in promoting sustained compliance.

Genetic factors play a substantial role in craniofacial development, dental arch morphology, and orthodontic treatment response. Twin and family studies have consistently demonstrated moderate to high heritability of craniofacial characteristics [13–15,18]. Song et al. [13] reported significant genetic influence on craniofacial soft tissue morphology in monozygotic twins, while Germeç Çakan et al. [14] highlighted the genetic determinants of facial skeletal characteristics. Sidlauskas et al. [18] further demonstrated high heritability of mandibular cephalometric variables. These findings support the use of monozygotic twins as a biologically controlled model for evaluating orthodontic interventions.

By minimizing genetic variability, the present study allows treatment-related differences to be attributed more confidently to appliance-specific factors. This is particularly relevant in functional appliance therapy, where individual variability in growth response is substantial. Yue et al. [16] demonstrated that divergent treatment approaches can lead to different long-term outcomes in monozygotic twins despite identical genetic backgrounds. Such findings reinforce the scientific value of twin-based comparisons and highlight their potential role in refining orthodontic treatment protocols.

From a clinical perspective, the present findings emphasize the importance of individualized appliance selection. Although both appliances produced improvement in sagittal relationships, differences in dentoalveolar response, vertical control, and occlusal correction were evident. Clear functional appliances may be particularly advantageous in patients requiring enhanced esthetics, improved vertical control, and greater acceptance, whereas conventional twin block appliances remain reliable and cost-effective options in appropriately selected cases.

Furthermore, clinicians should recognize that functional appliance therapy rarely produces uniform skeletal effects across all patients. Comprehensive diagnosis, careful treatment planning, and continuous monitoring are essential to optimize outcomes and minimize undesirable compensatory changes. The integration of skeletal maturity assessment, growth pattern evaluation, and patient-related factors into appliance selection may enhance treatment predictability.

Clinical Implications

The results of this monozygotic twin case report have several important clinical implications. First, they highlight that appliance design can influence treatment outcomes even under near-identical biological conditions. Second, they emphasize the importance of considering vertical growth pattern and dentoalveolar effects when selecting functional appliances. Third, they suggest that esthetic appliance designs may enhance patient acceptance and potentially improve treatment efficiency.

Clinicians should recognize that functional appliance therapy does not produce uniform skeletal effects in all patients and that dentoalveolar compensation often plays a substantial role in sagittal correction. Careful case selection, appliance design, and monitoring of incisor inclination and vertical changes are therefore essential to optimize outcomes.

5. Conclusions

Within the limitations of this monozygotic twin case report, both the clear functional jaw corrector and the conventional twin block appliance were effective in improving skeletal Class II malocclusion during the growth phase.

The clear functional appliance demonstrated greater sagittal improvement, superior vertical control, and complete molar and canine correction. In contrast, the conventional twin block appliance exhibited greater dentoalveolar effects and incomplete canine correction.

Monozygotic twin-based comparisons represent a powerful and underutilized research model for evaluating orthodontic appliance effects by minimizing genetic and environmental confounders. Such studies should be encouraged in future clinical research to strengthen the scientific basis of functional appliance therapy.

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Data Availability Statement: The datasets generated and/or analyzed during the current study are not publicly available due to the personally identifiable nature of radiographic and photographic images but are available from the corresponding author on reasonable request and subject to institutional and ethical review. De-

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