Case Report

Twin block therapy in a child with class II malocclusion and mouth breathing assisted by AI-driven software for cephalometric analysis: case report

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ABSTRACT

Introduction: The Twin Block appliance is widely recognized as an effective treatment for Class II malocclusion in growing children. While cephalometric analysis software, including AI-based tools, is a well-established diagnostic aid, its integration into treatment planning enhances diagnostic precision and progress monitoring. This case report aims to highlight the management of a child with Class II malocclusion and mouth breathing using a Twin Block appliance, assisted by AI-driven software for cephalometric analysis to enhance treatment outcomes. **Case Report:** A 10-year-old boy presented with forward-positioned teeth and low self-confidence. Clinical examination revealed Class II malocclusion characterized by upper incisor protrusion and mandibular retrusion. The water-retention test confirmed mouth breathing. AI-driven cephalometric analysis using WebCeph showed an SNB angle of 75.59° and an ANB angle of 6.77°. The patient underwent nine months of Twin Block therapy with monthly adjustments. **Conclusion:** Twin Block therapy in this case was ineffective in achieving skeletal growth modification, likely due to factors such as treatment timing, skeletal maturity, or appliance design. AI-driven software for cephalometric analysis proved valuable for monitoring but should be viewed as a diagnostic tool rather than a determinant of treatment success.

KEYWORDS

AI-driven cephalometry, children, class II malocclusion, mouth breathing, twin block

INTRODUCTION

Class II skeletal malocclusions account for over one-third of all orthodontic cases globally and are considered one of the most common challenges in orthodontic practice, particularly Class II Division 1 malocclusion. Due to the pronounced overjet associated with this condition, there is an increased risk of incisor injury, as well as a link to psychological issues such as bullying and harassment. Furthermore, it adversely affects oral health-related quality of life. The etiology of this malocclusion is multifactorial, with mouth breathing being one contributing factor. McNamara and various studies emphasize that mandibular deficiency, specifically mandibular retrognathia, is the primary cause of Class II malocclusion, rather than maxillary prognathism.[1–3]

Introduced in Europe in the early 1900s, functional appliances encompass a wide range of orthodontic devices that have achieved global popularity over time. Numerous evidence-based studies on functional appliances have demonstrated varying cytoskeletal effects in treating Class II malocclusions. The Twin Block appliance, created by William J. Clark, has recently become one of the most widely used and extensively applied removable functional appliances for the treatment of Class II malocclusions in growing patients.[4,5]

Twin Blocks are used to correct facial imbalances in children with retrusive mandibles and increase airway dimensions and lung volume. The Twin Block is an effective orthodontic appliance used to correct facial imbalances in children with a retrusive mandible. This appliance works by positioning the mandible forward through the use of upper and lower acrylic blocks, guiding the mandible into the correct position during natural activities such as chewing and speaking.[6]

This functional appliance harnesses the forces generated by the masticatory muscles to stimulate adaptive growth of the mandible, promoting forward remodeling of the jaw in response to the altered functional environment. In addition to advancing the mandible, the Twin Block results in changes to the oropharyngeal airway dimensions due to oropharyngeal capsule expansion, which results from the stretching and stimulation of the oropharyngeal muscles.[7]

The forward repositioning of the mandible also leads to the forward relocation of the tongue, which opens up the pharyngeal space and reduces airway resistance. This improved airflow enhances oxygen exchange efficiency and decreases respiratory effort, ultimately contributing to better pulmonary function. Over time, this process leads to an increase in lung volume as the respiratory system adapts to the enhanced airway dimensions and reduced resistance. Recent studies have shown that the use of the Twin Block can increase lung volume and improve overall respiratory function in children with Class II malocclusion and a retrusive mandible. Thus, the Twin Block provides both orthopedic and physiological benefits, particularly for children with respiratory issues or skeletal discrepancies.[1,7–11]

Early orthodontic treatment aims to correct or prevent malocclusion, thereby minimizing the need for more complex procedures during the permanent dentition stage. The timing of treatment for Class II malocclusion is critical, with the optimal period for initiation being around the pubertal growth spurt. Patient compliance is also a key factor in the success of orthodontic treatment, particularly when using removable appliances.[12–14]

Cephalometric radiography is a crucial diagnostic tool for assessing dental and skeletal development and identifying the causes of abnormalities. This imaging technique aids in treatment planning, intervention evaluation, understanding the relationship between dental and cranial structures, and diagnosing malocclusion. Advancements in computer technology have significantly improved traditional manual cephalometric studies.[15]

Artificial Intelligence (AI)-based cephalometric analysis techniques may be categorized as semi-automatic or fully automatic. Several studies using the web-based program WebCeph (Assemble Circle, Seoul, Republic of Korea) have assessed the accuracy and reliability of direct digital radiograph measurements. WebCeph's digital tracing is considered suitable for clinical use and has shown accuracy comparable to traditional manual cephalometric tracing.[15–17]

The Twin Block appliance is widely recognized as a successful treatment for Class II malocclusion in growing children. Cephalometric analysis software, including AI-driven tools, is a well-established diagnostic aid commonly used in orthodontics. This case report describes the orthodontic treatment of a child with Class II malocclusion and mouth breathing using the Twin Block appliance. This report uniquely incorporates AI-driven ‘WebCeph’ software to precisely assess treatment progress. Additionally, it explores the functional benefits of Twin Block therapy, particularly in transitioning from mouth to nasal breathing. By evaluating the appliance’s effect on both skeletal and dental structures at an early growth stage, this case provides valuable insights into the limitations and benefits of early intervention in Class II malocclusion management.

Case Report

The patient was a 10-year-old boy who came with his mother to the Pediatric Dental Clinic of Padjadjaran University Dental Clinical Hospital, presenting with the main complaint that his teeth appeared pushed forward and affecting his self-confidence. The patient's mother reported that he kept his mouth open when resting during the day, especially while sleeping. Additionally, she mentioned that the patient had a history of asthma triggered by cold air or drinks since the age of six months, which had not recurred since he was around six years old. The patient had a family history of asthma from his paternal grandfather.

Extraoral examination showed that the mandible was more retrusive than the maxilla, resulting in a convex facial profile. Evaluation of body posture indicated a slight forward head posture, a common feature in mouth-breathing patients (Figure 1). A water-retention test was performed to evaluate breathing patterns (Figure 2). The patient was asked to hold a small amount of water in his mouth with closed lips. Water seepage around the corners of the mouth indicated that the patient habitually breathed through his mouth during rest and sleep. The patient presented with a Class II appearance with a mesofacial pattern.

Figure 1. Facial profile and body posture of the patient before treatment

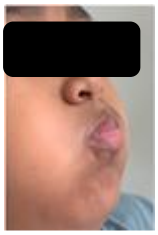

Figure 2. Water retention test before treatment

The upper incisors appeared protruded on intraoral examination, while the lower incisors were relatively upright (Figure 3). With an overjet of 8 mm and an overbite percentage of 91.36%, the analysis results showed Class II molar relations on both sides, Class I right canine relation, and Class II left canine relation (Figure 4).

Figure 3. Pre-treatment intraoral photo. (A) ventral view, (B) right-side view, (C) left-side view, (D) upper occlusal view (E) lower occlusal view

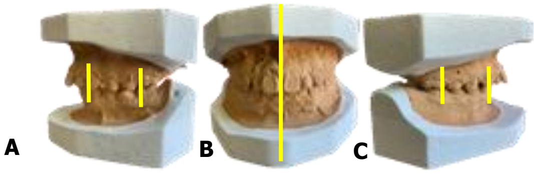

Figure 4. Pre-treatment model study. (A) Class II molar with Class II left canine relation, (B) Patient's midline, (C) Class II molar with Class I right canine relation.

The panoramic radiograph revealed symmetrical condylar heads on both sides, with no signs of muscle pain or joint discomfort, indicating the absence of temporomandibular disorders. Furthermore, the radiograph clearly depicted the complete tooth bud of the third molar (Figure 5).

Figure 5. Panoramic X-ray

Pre-treatment cephalometric analysis was performed using artificial intelligence (AI)-based WebCeph software, with the adjusted measurements shown in Figure 6. The cephalometric analysis revealed an SNA angle of 82.28°, indicating an average position of the upper jaw relative to the base of the skull. In contrast, the SNB angle of 75.50° suggested that the mandible was positioned more posteriorly than normal, aligning with the diagnosis of Class II malocclusion.

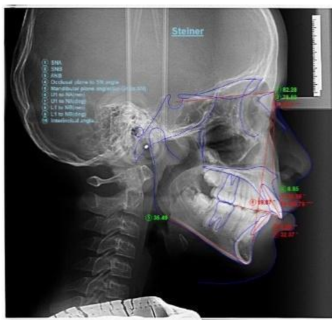

Figure 6. Webceph pre-treatment cephalometric analysis

A significant skeletal discrepancy was observed from the ANB angle of 6.77°, indicating that the lower jaw was retrusive relative to the upper jaw. The GoGn-SN angle of 35.49° suggested a mandibular slope slightly steeper than usual, consistent with moderate vertical facial growth. The interincisal angle of 109.79° revealed that the upper and lower incisors were more protrusive toward each other, correlating with occlusal alterations. At the U1 to NA angle, a measurement of 6.85° indicated that the upper incisors were more upright or retrusive than expected.

In contrast, a linear U1 to NA value of 30.86 mm indicated the presence of a linear protrusion of the upper incisors despite the slight angle. The L1 to NB angle of 32.57° indicated that the lower incisors were significantly protrusive, with a linear L1 to NB value of 8.80 mm, reflecting significant protrusion of the lower incisors. Thus, the patient was diagnosed with Class II skeletal malocclusion associated with mouth breathing. The patient was scheduled to undergo treatment with a Twin Block appliance. Based on cephalometric analysis, the patient was at the Cervical Vertebrae Maturation (CVM) stage 2. This indicates that the treatment was initiated before the peak of pubertal growth spurt, yielding a moderate to good prognosis.

Considering that the patient was still in the growth phase, the primary objective of treatment was to decrease the overjet through skeletal correction, which would in turn support and promote mandibular development. Enhancing lip competence to encourage nasal breathing was also a key treatment goal. The treatment plan was discussed with the patient and his mother, who opted to proceed with the use of a Twin Block appliance to support mandibular growth.

Class II malocclusion can be treated with or without extractions following functional therapy. However, due to excessive proclination of maxillary incisors, distalizing the entire maxillary arch using temporary skeletal anchorage devices (TSADs) and controlling the vertical position of the maxillary first molars can improve the Class II skeletal relationship. Another treatment option involves extracting the maxillary first premolars to establish Class II molar and Class I canine relationships, or extracting both the maxillary first premolars and mandibular second premolars to correct the malocclusion.[15]

Treatment began with the use of the Twin Block appliance, originally developed by Clark (Figure 7). The jaw registration shows a 7mm protrusion with tooth blocks 3-4mm apart in buccal segments. The steep inclined planes were interlocked at a 70° angle to the occlusal plane, and the appliance was adjusted monthly for nine months. The patient was instructed to wear this device 24 hours a day, including during meals. The final assessment utilized AI-driven software for cephalometric analysis to evaluate the treatment outcomes, including skeletal and dental relationships. An intraoral photograph of the patient following Twin Block therapy is shown below (Figure 8).

Figure 7. (A) Anterior occlusion, (B) right molar twin block, and (C) left molar twin block

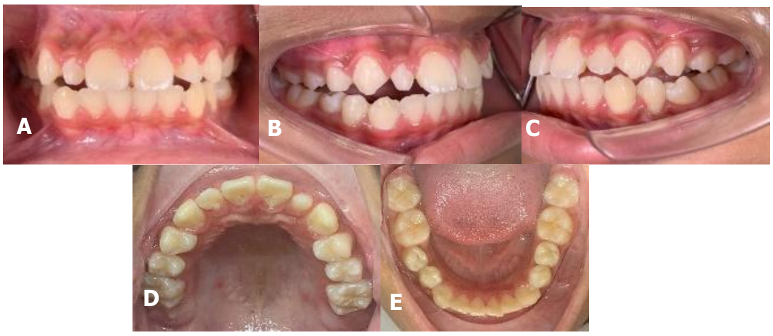

Figure 8. Post-treatment intraoral photo. (A) ventral view, (B) right-side view, (C) left-side view, (D) upper occlusal view, (E) lower occlusal view.

After nine months of Twin Block therapy, normal overjet and overbite were achieved, with an overjet of 3.5 mm and an overbite percentage of 25.93%. However, there was an overcorrection in molar relationships, resulting in super Class I molar and Class I canine relationships on both sides (Figure 9).

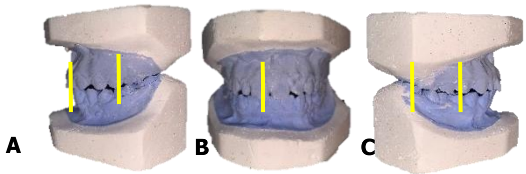

Figure 9. Post Treatment Study Model. (A) Super Class I molar with Class I left canine relations, (B) Patient's midline, (C) Super Class I molar with Class I right canine relations.

Post-treatment cephalometric analysis using customized artificial intelligence (AI)-based WebCeph software is presented in Figure 10.

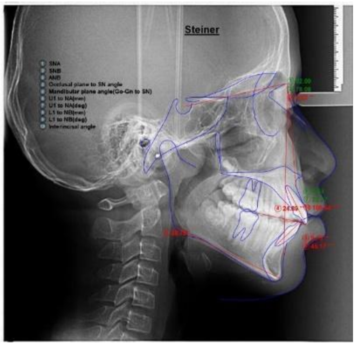

Figure 10. WebCeph post-treatment cephalometric analysis

The results of the repeat cephalometric analysis performed after treatment with WebCeph demonstrated changes in several key parameters. Notably, the SNA (Sella-Nasion-A Point) angle decreased from 82.28° to 82.09°. The SNB (Sella-Nasion-B Point) angle slightly increased from 75.59° to 76.08°. The ANB angle decreased from 6.77° to 6.02°. The Occlusal Plane to SN angle increased from 19.87° to 24.89°.

The Mandibular Plane Angle (GoGn-SN Angle) showed an increase from 35.49° to 38.79°. The U1 to NA (Upper Incisor to Nasion-A) angle reduced from 6.85° to 4.03°, and the linear distance decreased from 30.86 mm to 22.37 mm. Meanwhile, the L1 to NB (Lower Incisor to Nasion-B) angle increased from 32.57° to 45.17°, with the linear distance increasing from 8.80 mm to 9.75 mm. The interincisal angle decreased from 109.79° to 106.54°. A comparative image illustrating the pre- and post-treatment changes is presented in Figure 11.

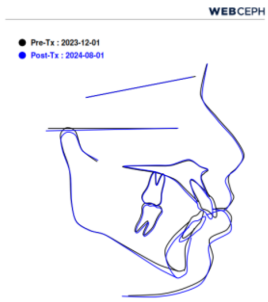

Figure 11. Pre- and post-treatment comparison from WebCeph

The patient underwent therapy with a Twin Block appliance to correct mandibular retrusion and improve occlusal function. AI-driven software was utilized to evaluate changes in jaw and tooth positions during treatment. The therapy lasted nine months, with appliance adjustments based on clinical evaluations. The patient's parents reported a notable improvement in breathing patterns, particularly at night, and consistent lip seal during sleep. The water retention test indicated that the patient was able to retain water in his mouth without any seepage around the corners, demonstrating the patient's ability to breathe through the nose (Figure 12). The patient's body posture appeared upright when standing (Figure 13).

Figure 12. Water retention test after treatment

Figure 13. Facial profile and body posture of the patient after treatment

DISCUSSION

The patient had a long medical history of asthma, a disease linked to an increased prevalence of mouth breathing. According to research by Dos Santos et al., mouth breathing habits and asthma are significantly correlated.[18] Research suggests that individuals with asthma are more likely to develop mouth breathing patterns than those without the condition due to frequent airway obstruction.[19] Notably, patients with mild asthma tend to switch from nasal breathing to oronasal (mouth-and-nose) breathing at significantly lower levels of nasal inspiratory load compared to healthy individuals. This condition can lead to negative effects on oral health and maxillofacial development, particularly in growing patients.[20]

Changes in breathing patterns that promote mouth breathing trigger a series of functional changes affecting the position of the tongue, mandible, and muscle balance in and around the mouth. Individuals who breathe through their mouths typically adopt a forward head posture to facilitate airflow. This shift in head and neck position adjusts the angle of the pharynx, thereby improving air entry through the mouth and increasing airflow in the upper airway.[21,22]

In clinical practice, visual observation of the patient, questioning of the child or parents, and respiratory testing are the main techniques used to diagnose a child's breathing pattern. The mirror test and the water retention test are two of the most frequently mentioned evaluations in the literature. Individuals who breathe through their mouth typically struggle to hold water in their mouths for an extended period.[23–26]

Mouth breathing is frequently regarded as a major risk factor for the development of malocclusion.[27] As an adaptive response, mouth breathing alters the morphology of the lips, tongue, and mandible, which in turn influences the skeletal system through neuromuscular mechanisms. This condition affects the patient's facial growth pattern.[26] It leads to skeletal discrepancies between the upper and lower jaws, as evidenced by the initial cephalometric results showing an SNB angle of 75°, indicating mandibular retrusion. Lower SNB values are commonly observed in patients who breathed through their mouths. The SNB angle is positioned posteriorly relative to the cranial base due to the forward and lower positioning of the tongue.[22]

Mouth breathing in children is usually associated with a Class II skeletal facial profile, characterized by mandibular retrusion and maxillary protrusion.[23,24] This condition is often accompanied by clockwise mandibular rotation,[23,24] increasing the height of the lower face.[20,28] Before treatment, the patient had a GoGn-SN of 35.49°, indicating a moderate vertical growth pattern. Research indicates that children with mouth breathing have a greater angle of the mandibular plane in relation to the anterior cranial base (SN-GoGn) compared to those who breathe through their noses.[21]

Class II malocclusions can be treated using growth modification, which involves active and passive devices that influence the function of orofacial muscles to facilitate optimal bone growth. By mimicking the actions of the perioral muscles, these appliances apply forces to the teeth and basal bone, promoting orthodontic and orthopedic changes. Early intervention in children with endoskeletal malocclusions or muscular disorders leads to better outcomes and more stable jaw alignment. The adaptability of the bones in preschool-age children allows for faster and longer-lasting treatment results, ensuring long-term stability.[1,29]

Treatment with the Twin Block is popular due to its higher rates of patient acceptance and compliance. The device's two-piece design, with separate upper and lower components, allows for greater freedom in speaking and chewing, making it more comfortable for patients to wear. Patient compliance is the primary issue with removable functional devices as they can affect speech and oral function, leading to discomfort for some patients. Prospective studies have shown failure rates of up to 34% for the Twin Block therapy, primarily due to noncompliance.[1,8]

The patient's parents actively encouraged their child to follow instructions for using the Twin Block. Patient compliance is a critical factor in orthodontic treatment success, especially with removable appliances. Various factors can influence compliance, serving as either barriers or facilitators. Barriers to adherence may encompass the patient's quality of life while using the device, their level of intrinsic motivation, and concerns about aesthetics. The Twin Block appliance incorporates wire components, which can lead to tissue irritation and may necessitate frequent adjustments. Furthermore, the wire elements on the anterior surfaces of the teeth can negatively affect the patient's aesthetic perception.[12,13]

Patients occasionally report pain in the molar area and difficulty speaking during the initial use of the appliance. Lee et al. reported that approximately 21.43% of patients experienced pain during treatment, particularly in the molar region. Changes in speech were also observed in 21.43% of patients following the initial placement of the device. However, speech gradually improved with continued use of the appliance.[30]

In this case report, there was a limited increase in the SNB angle from 75.59° to 76.08° after using the Twin Block appliance. The Twin Block appliance's occlusal inclined plane functions as the primary mechanism that mimics the dentition of the natural teeth, hence the angle of this plane is important in establishing the dental relationship. The occlusal forces transmitted through the teeth provide continuous proprioceptive stimulation, which significantly influences growth rates and the trabecular structure throughout development.

The design of the appliance also plays a crucial role in determining the success of treatment. The Twin Block appliance was initially designed for full-time wear, including during meals. Its construction features an edge-to-edge bite with a small interincisal space, typically around 2 mm, which encourages patients to maintain natural lip closure. This posture is reinforced as patients eat and drink while wearing the appliance, promoting the early development of competent lips and normal lip position. These behaviors persist throughout treatment and are well-established by the end of the Twin Block phase, at which point the incisors and molars are expected to be in proper occlusion. An ideal vertical opening should have a thickness of at least 5-6 mm in the premolar region.

The inaccuracy in following the twin block design technique, which results in excessively thick occlusal blocks, may cause patients to experience difficulty eating and drinking. Consequently, patients may frequently remove the appliance, adversely impacting the overall success of the treatment. However, an excessively thin bite block may potentially render the treatment ineffective. A thin bite block allows the patient to retract the mandible to a rest position, preventing proper closing of both lower and upper jaw blocks. This reduces the efficiency of the functional mechanism, resulting in a failure to repair distal occlusion.[11,31,32]

The Twin Block is a removable functional appliance consisting of two bite blocks, one for the maxilla and one for the mandible. This appliance utilizes a protrusive bite to modify the cuspal inclined planes. To optimize horizontal force transmission and maintain a comfortable forward mandibular posture, the maxillary and mandibular bite blocks must meet at an angle of 70°. This angulation is essential for promoting skeletal changes and correcting sagittal skeletal discrepancies. Thus, achieving a precise 70° angulation during fabrication is critical.[11,31,32]

In the context of treating Class II malocclusions, timing is crucial, with the optimal initiation of treatment occurring during the pubertal growth spurt. The pubertal growth spurt can be identified using the cervical vertebral maturation (CVM) method observed through lateral cephalometric radiographs. Cervical stage (CS) 1 and CS 2 are considered prepubertal, CS 3 and CS 4 circum-pubertal, and CS 5 and CS 6 postpubertal. CS3 and CS4 represent the most optimal periods for growth modification, as they coincide with the peak mandibular growth rate. The stage preceding CVM CS3 or following CS4 is deemed too early or late for effective growth modification treatment.[33,34]

According to the study by Khoja et al., treatment with the Twin Block appliance demonstrated significantly more pronounced effects during the CS3 stage compared to other stages. Furthermore, another study in Malaysia found that Twin Block treatment initiated at CVM CS5 only had a 42.9% success rate. Treatments that fail to align with the peak period of mandibular growth are more likely to result in dentoalveolar alterations rather than achieving substantial skeletal growth modifications. In this case, the patient was treated earlier during the CS2 stage. Early intervention aimed to address psychosocial concerns related to protruding teeth, which can negatively impact self-confidence, and to reduce the risk of dental injury commonly associated with such conditions.[12,13]

The patient's SNA (Sella-Nasion-A Point) measurement before treatment was 82.28°, decreasing slightly to 82.09° after treatment. This indicates that while the position of the upper jaw experienced a slight reduction, it did not undergo significant changes and remained within the normal range. The Twin Block appliance reduces maxillary growth by 13%, primarily due to the stretching of muscles and soft tissues surrounding the facial skeleton. This results in a "headgear effect," a restrictive effect on the maxilla, as the advancing mandible reverts to its original position.[35]

The ANB angle decreased slightly from 6.77° to 6.02°, possibly due to the forward movement of the mandible. The anteroposterior relationship between the upper and lower jaws showed some improvement, although the change was not significant. This outcome aligns with one of the primary objectives of therapy for patients with Class II malocclusion. However, the main therapeutic goal for these patients was not fully achieved.[36] The patient's breathing pattern was reportedly corrected, according to his parents, as they observed no more mouth opening during day and night. Changes were also observed in the lower incisor to SNB angle, which increased from 32.57° to 45.17°, indicating considerable protrusion of the lower incisors. This change improved the overjet from 8 mm to 3.5 mm, enhancing the occlusal relationship between the upper and lower incisors. Meanwhile, the interincisal angle decreased from 109.79° to 106.54°, indicating that the upper and lower incisor edges became more upright relative to each other. This adjustment contributed to improvements in anterior segment occlusion and lip seal, particularly considering the impact of mouth breathing on the patient's ability to do the nasal breath.

Proper lip competency facilitates an effective oral seal, which plays a key role in maintaining the stability of orthodontic treatment. Overjet reduction occurs due to the increased inclination of the lower incisors resulting from the absence of dental interdigitation fixation. Compared to clear aligners, the Twin Block appliance is more likely to cause compensatory proclination of the lower incisors, likely due to its incomplete tooth coverage. The lack of rigid tooth contact allows for greater freedom of movement in the lower incisors. Thus, clear aligners may be a particularly beneficial treatment option for cases requiring less skeletal change or those where precise control over incisor positioning is essential.[37,38]

In this case, cephalometric analysis was conducted with the assistance of semi-automatic artificial intelligence (AI)-driven software, namely WebCeph, which offers significant advantages in terms of speed and accuracy. AI technology can automatically detect important craniofacial anatomical points, such as Nasion (N), Sella (S), A Point, B Point, and incisor teeth. This functionality can be combined with the manual selection of reference points, allowing for the automatic calculation of various cephalometric parameters. Compared to digital tracing using FACAD and manual tracing techniques, WebCeph is a more reliable, practical and useful tool for cephalometric study.[17,39,40]

The patient and parents were satisfied with the use of the Twin Block appliance, particularly regarding improvements in breathing. However, there were still complaints about wearing the appliance during the day. A total of 85.71% of patients reported satisfactory responses to Twin Block therapy, indicating an acceptable response rate. In contrast, 14.29% of patients expressed dissatisfaction with the device. Wearing this appliance during the day, including while attending school, seemed comfortable for most patients.[41]

On both sides, there were super Class I molar relationships due to a slight overcorrection in the molar relationships. Functional appliances are preferable for slightly overcorrecting the buccal segments (molars and canines) to a super Class I position to minimize the potential for relapse.[39] Continuous monitoring is necessary in order to ensure the long-term stability of the outcomes and prevent the recurrence mouth breathing or malocclusion. The patient and their parents will continue with fixed orthodontic treatment after receiving education on the importance of ongoing treatment to achieve ideal occlusion.

This case report has several limitations. First, it focuses on a single patient, limiting the generalizability of the findings to a broader population. Second, while AI-driven software for cephalometric analysis provided diagnostic support, it primarily served as a supplementary tool and did not significantly impact treatment outcomes compared to traditional diagnostic methods. Third, the long-term effects of Twin Block therapy on both respiratory function and mandibular growth were not assessed, due to the relatively short follow-up period. Fourth, the primary aim of Twin Block therapy, which is skeletal growth modification in a growing patient with skeletal class II malocclusion, was not achieved. The observed changes were primarily dental effects, as indicated by the increased incisor inclination and the persistence of a large ANB value.

Further studies with larger sample sizes and extended follow-up periods are needed to validate and expand upon the findings of this report. AI-driven software should be considered a supportive diagnostic tool rather than a primary determinant of treatment success. This case demonstrates that although Twin Block therapy may have limitations in achieving skeletal modifications in certain cases, its effectiveness in addressing functional issues like breathing patterns highlights its broader therapeutic value. Additionally, the integration of AI-driven software as diagnostic tools in orthodontic care shows promise for developing more precise, individualized treatment approaches for growing children.

CONCLUSION

In this case, Twin Block therapy demonstrated limited effectiveness in achieving skeletal growth modification, possibly due to factors such as skeletal maturity, treatment timing, and appliance design. Nevertheless, the therapy successfully transitioned the patient from mouth breathing to nasal breathing, leading to significant improvement in respiratory function and overall quality of life. The AI-driven software for cephalometric analysis provided valuable diagnostic insights, precise landmark identification, and real-time progress tracking for treatment planning and monitoring. The implications of this case highlight the importance of initiating functional appliance therapy at the optimal growth stage to maximize skeletal correction, the functional benefits of Twin Block therapy beyond occlusal changes, and the necessity of fixed orthodontic treatment to ensure long-term stability. The growing role of AI-driven software in orthodontics suggests its potential for improving predictive modeling of treatment outcomes. However, AI-driven software should be integrated alongside clinical judgment and conventional diagnostic methods to ensure comprehensive treatment planning.

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