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Research Report

Dentoalveolar changes in post-twin block appliance orthodontic treatment class II dentoskeletal malocclusion

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ABSTRACT

Background: *The analysis of cephalometric radiographs provides information about facial skeletal structures, jaw bone-base relationships, incisive-axial inclination relationships, soft tissue morphology, growth direction and pattern, malocclusion classification and the limitations of orthodontic treatments. In class II malocclusion, the mesiobuccal cusp of the permanent maxillary first molar rests between the first mandibular molar and the second premolar. A twin block appliance is recommended to treat Class II dentoskeletal malocclusion with retrognathic mandible characteristics.* ***Purpose:*** *The aim of this study was to analyze the dentoalveolar alterations in class II dentoskeletal malocclusion with retrognathic mandible characteristics after orthodontic treatment with twin block appliance based on a Steiner analysis.* ***Methods:*** *This research constitutes a retrospective study using secondary data derived from the lateral cephalometric radiographs of patients with Class II malocclusion treated with twin block appliance at the Pediatric Dentistry Department of the Oral and Dental Hospital, Universitas Padjajaran, Bandung. The data was analyzed using a T-test for normally distributed paired data. In cases where data was not normally distributed, a Wilcoxon test was employed.* ***Results:*** *The average measurements showed statistically significant dentoalveolar changes among class II malocclusion patients after twin block appliance treatment when analyzed using the paired t-test based on Steiner method cephalometric radiograph analysis ($p < 0.05$).* ***Conclusion:*** *It is concluded that a twin block appliance is effective in treating class II dentoskeletal malocclusion with a retrognathic mandible based on dentoalveolar changes resulting from Steiner analysis*

Keywords: *cephalometric; dentoalveolar alterations; dentoskeletal malocclusion; retrognathic mandible; twin block*

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INTRODUCTION

Numerous clinical studies have been conducted to reveal the skeletal and dentoalveolar changes related to the treatment of class II malocclusion. However, the implications of the resulting scientific data are still debatable.[1] Several studies have argued that the skeletal effects induced by the functional appliances significantly influenced mandibular growth, while others indicated that they might have little effect on skeletal changes. Major modifications identified following orthodontic treatment with functional appliances include those dentoalveolar in nature, i.e. distalization of the buccal part and retroclination of maxillary anterior teeth, along with mesial changes in the buccal section of mandibular teeth and proclination of their labial sections.

The availability of a diagnostic report supported by study models, radiographs and images showing the pre-treatment conditions necessary to select the form of malocclusion treatment and to assess its effectiveness was essential.[2] The analysis of cephalometric radiographs provided information regarding facial skeletal structures, jaw bone-base relationships, incisive-axial inclination relationships, soft tissue morphology, growth direction and pattern, malocclusion classification, and limitations on orthodontic treatments.[3] The purpose of cephalometric

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radiograph examination is to evaluate the face type, jaw-cranial base relationship, growth pattern, dentoalveolar relationship, the position of malocclusion, soft tissues and their relationship with regard to etiology and prognostics, functional relationship, and therapeutic possibilities.[4]

The method frequently used to analyze cephalometric radiographs as part of dentofacial relationship evaluation is that of a Steiner analysis. This form of analysis is the most widely employed because it is simple, easy to understand and produces maximum clinical information with minimal methods that include calculation of the position and inclination of the teeth in relation to the jaw and the position of the jaw vis-a-vis the cranium base.[4] The outcome of incompatible treatment may be due to incorrect line points in pre- and post-treatment cephalometric radiograph analysis. This creates difficulties in assessing the real involvement of the skeletal and dentoalveolar components in the changes evident in the treatment outcome.[5]

Cephalometric radiographs are frequently used to identify and evaluate changes during malocclusion treatment.[4] The World Health Organization stated that malocclusion is a dentofacial abnormality leading to defects in both appearance and function which affect a person both physically and mentally. Malocclusion is a deviation from the ideal occlusion that may cause discomfort and, specifically, poor esthetics. This is due to the imbalance in size and position of teeth, facial bones and soft tissues (lips, cheeks, and tongue).[6,7]

Edward Angle stated that class II dental malocclusion is defined as a condition where the first mandibular molar is more distal than under normal occlusion in relation to the first maxillary molar. The British Dental Institute defined class II malocclusion as a condition where the mandibular incisor edge is in a posterior position in relation to the palatal cingulum of the maxillary incisor in a proclined inclination with increased overjet.[8] An epidemiological study at an elementary school in Jakarta confirmed the prevalence of the class II malocclusion as one of 31.6%.[9]

Several mandibular proclination methods applied to correct class II malocclusion include: functional and extraoral appliances, camouflage treatment and surgical jaw repositioning.[5,10] The functional appliances comprise: bionators, FR-2 or Frankel, fixed and removable Herbst functional appliances and the twin block appliance introduced by William J. Clark.[11] The twin block appliance consists of maxillary and mandibular acrylic plates with bite blocks that guide the mandible to a forward position during closure of the mouth.[10] The indication of the twin block appliance is to correct class II dentoskeletal malocclusion with mandibular retrognathy.[10–13]

A comparative study between patients treated with twin block appliances and a control group showed a significant increase in mandible length, but with the frequent occurrence of overjet correction as a result of dentoalveolar compensation.[12] Meanwhile, a comparative study of twin blocks and other functional appliances confirmed the former to be the best functional appliance for producing sagittal modification; including: mandibular skeletal changes, dentoalveolar changes and normal growth pattern changes.[13]

This study aimed to analyze post-orthodontic treatment dentoalveolar modifications using twin block appliances in class II dentoskeletal malocclusion with retrognathic mandibles based on a Steiner analysis.

MATERIALS AND METHODS

The study reported here was retrospective analytical in nature incorporating a purposive sampling method based on the secondary data derived from a lateral cephalometric radiograph of class II dentoskeletal malocclusion with retrognathic mandible patients. During the period 2010–2017, these individuals were treated using twin block appliances at the Pediatric Dentistry Installation of the Oral and Dental Hospital, Universitas Padjadjaran, Bandung. Dentoalveolar alterations were assessed using Steiner cephalometric radiograph analysis (I-NA angle, I-NA distance, I-NB angle, I-NB distance, and interincisal angle).

Steiner analysis was also used to recognize the relationship between the position of the jaw and cranial base, the position of the mandible against the maxilla, in addition to that of teeth in the arch. The dentoalveolar alteration indicators employed in the Steiner analysis include: the maxillary first incisor inclination angle (I-NA angle), the anteroposterior position of the maxillary first incisor against the maxilla (I-NA distance), the mandibular first incisor inclination angle (I–NB angle), the anteroposterior position of the mandibular first incisor against the mandible (I–NB distance), the axial inclination angle between the maxillary and mandibular first incisors (interincisal angle). These measurements were taken pre- and post-treatment by means of a twin block appliance.

Data was evaluated using a Shapiro-Wilk test on a small sample (Ý50) before analysis. Normally distributed paired data was analyzed using a T-test. If data was not normally distributed, a Wilcoxon test would be used.

RESULTS

This study was performed during the period March-April 2017. Twenty-one lateral cephalometric radiographs taken pre- and post-treatment using a twin block appliance were collected. The age of the samples ranged from 8 to 16 years, with and the majority being 11 years old. The number of male and female samples was almost equal, at 10 and 11 respectively.

Measurement of pre- and post-treatment dentoalveolar modification with the twin block conducted using a Steiner analysis are listed in Table 1. It was apparent that the I-NA angle, I-NA distance and interincisal angle demonstrated very significant statistical ($p < 0.01$) variation. The

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Table 1. Average comparative testing on dentoalveolar change measurement before and after treatment with the twin block

	Variable	Measurement Before Treatment	After Treatment	Nilai p*
Steiner Analysis	I-NA (^{0})			< 0.01*
	Mean (SD)	31.21 (7.38)	26.59 (8.31)	
	Range	14 – 44.5	6.5 – 40.5	
	I- NA (mm)			< 0.01**
	Mean (SD)	7.61 (2.13)	4.98 (1.38)	
	Range	3.5 – 11,0	1.5 – 7.5	
	I-NB (^{0})			0.931
	Mean (SD)	32,46 (6,66)	32.36 (6.51)	
	Range	20 – 43.5	17.5 – 43	
	I-NB (mm)			0.011*
	Mean (SD)	6.86 (2,32)	5.69 (2.20)	
	Range	3.5 – 11.5	1.2 – 11.5	
	Interincisal Angle (^{0})			< 0.01**
	Mean (SD)	108.09 (8.66)	115.60 (8.09)	
	Range	94.5 – 127.0	100.0 – 129.5	

Description: Data was analyzed using paired t-test with a significance score of p < 0.05 (significant) (*) and p < 0,01 (very significant) (**)

Table 2. The percentages of reduction in dentoalveolar changes based on cephalometric radiographs in class II dentoskeletal malocclusion retrognathic mandible treatment using twin block in the Oral and Dental Hospital, Universitas Padjadjaran

No.	Variable	% Decrease
1	I-NA angle	15.0
2	I-NA distance	32.1
3.	I-NB angle	3.2*
4	I-NB distance	14.1
5	Interincisal angle	-7.3

Description: *data used the median score due to not being normally distributed.
(–) increase

I-NB distance also demonstrated a significant variation (p < 0.05). The I-NB angle did not show any significant change (pš0.05).

The percentage reduction in dentoalveolar changes are listed in Table 2. The (–) mark on the interincisal angles in the table represents an increase in angle percentage which is inversely proportional to that of other angles. The greatest decrease occurred in I-NA distance (32.1%).

DISCUSSION

A dentoalveolar relationship is one between the maxillary and mandibulary dentoalveolar processes (apical base) and respective skeletal base and the craniofacial bone.[1] This dentoalveolar relationship may experience changes. A distal step dentoalveolar relationship in primary teeth will become a class II molar relationship in permanent ones.[14] The terminal planes during primary and mixed dentition may develop into an unpleasant relationship (class II molar relation) in permanent teeth. In this case, observation should be undertaken carefully to ensure that orthodontic treatment can be performed as early as possible. Several factors are involved in the development of the molar dentoalveolar relationship, including flush terminal plane relationship, leeway space, mandibular growth and environmental factors affecting the dental arch pattern.

In class II malocclusion, the mesiodistal cusp of the maxillary first permanent molar occludes mesially to the buccal groove of the mandibular first permanent molar. This creates a disharmony between the incisor teeth and the facial profile.[4,15–17] The main objective of orthodontic treatment using a twin block functional appliance is to stimulate mandibular lengthening by stimulating the growth of cartilage and condylar cartilage, as well as inhibiting the growth of the maxilla.

Growth modification treatment for class II malocclusion is recommended at an early age to prevent unfavorable growth patterns. Treatment performed during the primary and mixed dentition periods produces better results compared to that started on conclusion of the mixed dentition period.[17,18] Early treatment produced superior results, evidenced by greater efficiency in moving the mandibulla forward and inhibiting maxillar growth, while simultaneously correcting the occlusal relation.[19]

The samples analyzed were lateral cephalometric radiographs from class II dentoskeletal malocclusion with retrognathic mandible patients taken before and after orthodontic treatment using a twin block appliance. This study consisted of 21 samples taken from patients aged 8 to 16 years due to the fact that functional appliances

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were indicated for patients with a relatively good arch, mild or moderate class II skeletal pattern and who were experiencing a period of growth.[15]

Within a Steiner analysis, several angles are used as the reference for measuring the relationships between the maxillary first incisor and the maxilla, the mandibular first incisor and the mandible, and the maxillary and mandibular teeth.[20] According to the Steiner analysis, the results of measuring the average change in the dentoalveolar before and after treatment by means of a Twin Block appliance showed that there was a statistically significant change in I-NA angle, I-NA distance, I-NB distance, and interincisal angle. The greatest reduction was seen in I-NA distance.

Within this study, the primary change observable in functional treatment consisted of dentoalveolar changes comprising buccal distalization and maxillary anterior teeth retroclination as well as mesial-shifting of the buccal part of mandibular teeth and proclination of their labial section. Such findings are in line with a study performed by Sharma *et al*.[20] that indicated a significant increase in the interincisal angle in cases of orthodontic treatment utilising twin block appliances.

Within this study, a contrasting result was observed in the I-NB angle which confirmed there to be no statistically significant difference in this variable. This finding is similar to that of a study conducted by Tarvade *et al*.[21] that showed no proclination of the lower anterior teeth, while another piece of research revealed lower incisor proclination of 3.2^0.[2]

After treatment with twin block appliances, the reduction of proclination in the upper incisors was statistically significant. The contact between the labial bow in upper incisors and labial muscles produced a palatal retroclination of incisors. This result is to be expected from a treatment involving the use of a functional appliance due to the class II traction effect.[21]

Within this study, the lowest reduction was found in the I-NA distance and in the degree of upper incisor protrusion. This indicates that the anterior inclination of the upper incisor was reduced, due to palatal tipping movement of the upper incisor and forward movement of the pogonion.

The position of the lower mandibular incisor in class II is important in orthodontic treatment with functional appliances. Excessive labial tipping must be restricted to reduce the posibility of orthopedic alteration. After orthodontic treatment with twin block appliances, a proclination of the mandibular incisor in relation to the mandibular plane (IMPA) can be observed, even though it is statistically insignificant. Several studies reported significant proclination of mandibular incisors after treatment with twin block appliances, while the mandibular incisors remain stable in their position.[20]

This result may be explained by the design of the twin block appliance. The use of an acrylic cover on mandibular incisors and the eyelet clasps produce rigid retention on the labial lower jaw, as well as the use of sounthend clasps by Tarvade.[21] This study indicates that the twin block appliance reduces overjet through the combination of dentoalveolar and skeletal changes. The anterior teeth are significantly tipped on the upper arch, but insignificantly so on the lower arch. The construction of the twin block explains the tipping result of the upper incisors.

Functional appliances used in class II malocclusion treatment are designed to alter the mandible position both sagittally and vertically.[2] Therefore, the functional appliance is used in sagittal and vertical malocclusion treatment for patients in a growth and developmental period. The functional appliance works through back and forth mandibular movements, culminating in a stretching of soft orofacial and muscle tissues and myotatic reflexes resulting from muscle extension.[22]

The myotatic reflexes combined with the viscoelastic characteristics of the muscle exert stresses on both teeth and bone structure during the treatment. This muscle action is an important factor in generating of anticipated orthodontic and orthopedic forces. These forces are transmitted both directly and indirectly to the dentoskeletal tissues in order to correct malocclusion by increasing the sagittal intermaxillary relationship, i.e. changes in the molar relationship and decreased overjet.[21] This condition can also be seen in the results of this study. The correction of malocclusion is achieved through dentoalveolar modifications reflected in the cephalometric radiographs of class II dentoskeletal malocclusion with the retrognathic mandible treated by twin block appliances.

Treatment involving the use of functional appliances is intended to improve the functional relationship of dentofacial structures by eliminating poor growth factors and improving the muscle condition around the developing occlusion area. The amended dental position and supporting tissue will achieve the new functional pattern and be able to support the new position equally.[2,22]

The success of orthodontic treatment in class II dentoskeletal malocclusion patients depends on the growth and development of each individual and sufficient treatment time. The success of treatment with twin block appliances also depends on these factors, as well as being profoundly affected by patient cooperation, meaning that the outcome of the treatment will vary. Other factors include the age and maturity of the patient, growth pattern, etiology and initial severity of the malocclusion, duration of treatment, soft tissue characteristics and the force applied by the appliances. There are several factors affecting the stability of the treatment, i.e. mandibular growth rotation direction, respiratory tract obstruction, effective appliance manipulation, duration of treatment and sufficient retention period.[2] Twin block appliances may also prove able to correct transversal discrepancy in class II malocclusion by activating the screw in the palatal section. However, the twin block appliance usage can also cause a posterior open bite, resulting in the need for further fixed orthodontic treatment to correct the open bite.[22] It is concluded that a twin block appliance is effective in treating class II dentoskeletal malocclusion with retrognathic mandible

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based on dentoalveolar alterations resulting from a Steiner analysis.

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