Original Article

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The Effects of the Maxillary Splint Headgear in Comparison with Twin Block Appliance on Early Treatment of Class II Skeletal Malocclusion

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ABSTRACT

Background & Objective: Class II malocclusion is one of the most common types of malocclusion, and if untreated, can lead to speech and health problems, temporomandibular discomfort, trauma risk to maxillary incisors, and psychological issues. Early treatment with appliances like Maxillary splint headgear (MSH) or Twin block can, therefore, be highly impactful. The present study aimed to compare the effects of MSH and Twin block on cephalometric landmarks to make an informed decision for optimal treatment planning.

Materials & Methods: The research comprised sixteen patients treated with a maxillary headgear splint and sixteen patients treated with a Twin block, and lateral cephalometric radiographs were evaluated before and after treatment. These two groups were compared due to orthodontic parameters using an independent t-test or Mann-Whitney test.

Results: The results indicate that age and gender had no effect on the final treatment outcome. No significant differences were observed in cephalometric parameters (P>0.05) except for pre-treatment "ANB" and "Lip Competency at rest," which were higher in the MSH group (P=0.035 and 044, respectively).

Conclusion: MSH and Twin block are equally effective in treating Class II malocclusion.

Keywords: Extraoral Traction Appliances – Functional Orthodontic Appliance – Removable Orthodontic Appliance – Malocclusion Class II

Introduction

Malocclusions are among the most prevalent developmental disorders, severely affecting the quality of life for children and their families. Untreated, they may cause speech problems, dental health issues, temporomandibular joint pain, and most importantly psychological and social concerns include smiling and social interaction with others, resulting from bad aesthetics and social rejection (1). Class II malocclusion is one of the most prevalent types of malocclusions, defined by Angle as the distal positioning of lower molars in relation to the upper molars. Its prevalence varies in different regions due to ethnic and racial characteristics. For example, in the United States it's around 15% (2), whereas in Iran it is at about 21% (3, 4). Patients with a Class II growth pattern usually show a combination of mandibular retrognathism and too strong downward maxillary development, therefore affecting the vertical dimension of the posterior maxilla (5). In contrast to maxillary incisors, which often protrude, mandibular incisors are often well-positioned, which can result in an increased risk of damage to maxillary incisors, with one in three children with Class II malocclusion experiencing such damage (6, 7). Consequently, early intervention aimed at correcting increased maxillary protrusion via the retroclination of anterior teeth and subsequent growth modification can be beneficial, especially for individuals with concerns about dental and facial aesthetics as well as social and psychological issues related to their appearance. Moreover, it can address excessive space issues in the dental arch, and prove impactful for patients with a history of trauma or even as a preventive measure against trauma (6, 8).

In growing patients, stimulating forward mandibular growth or restricting maxillary growth in anterior and vertical directions is an ideal approach. Functional correctors, like the Bionator, Activator, Twin-Block, and similar devices, as well as headpiece appliances like the High-Pull and Low-Pull headgear, may be used to accomplish this therapy. In instances of significant malocclusion, surgical intervention may be required. The choice of which appliance to use in the treatment plan depends on clinical conditions, dental and skeletal factors, age, patient cooperation, and the dentist's preference (6).Considering previous studies (9, 10) comparing twin block and maxillary splint headgear (MSH) were insufficient which have primarily focused on comparing twin block with banded headgear, further studies are needed for proper decision-making in treatment planning. In order to examine the effects of twin block and MSH on the changes in each cephalometric landmark in the early treatment of Class II patients, this study was conducted. By comparing the results, we aimed to address present questions regarding the subtle impacts of each device.

Materials and Methods

This is a historical cohort study designed to compare dentoskeletal effects produced by two treatment modalities for correcting Class II malocclusion: MSH and the twin block. 2000 patient records from individuals seeking orthodontic treatment at the School of Dentistry, Shahid Beheshti University of Medical Sciences, between 2011 and 2021 were examined. 150 records were identified for patients in the growth age range of 8 to 14 years with skeletal Class II malocclusion. Among them, those undergoing treatment with either MSH or twin block with positive Wits appraisal and ANB angle higher than 4 degrees were included. The research excluded individuals with craniofacial deformities, non-cooperative patients, and patients utilizing other devices at the same time, patients with insufficient radiographs and pictures, and patients lacking dental models. The sample size was determined based on the study conducted by Phan *et al.* (11), using the average comparison formula within two groups, each consisting of 16 individuals, totaling 32 patients. The samples were selectively chosen using Convenience sampling method. Ultimately, 16 records of patients treated with MSH and 16 records of patients treated with a twin block, meeting the inclusion and exclusion criteria were included in the study.

Cephalometric and dental model analysis

After reviewing the records of eligible patients, lateral cephalometric radiographs were scanned using HP Scanjet G4050 Scanner (version 14.5.0.0, Hewlett-Packard Development Company, Palo Alto, California, USA). The scanned images were imported into the Dolphin Imaging software (version 11.0.03.37, Patterson Dental Holding, Inc., Saint Paul, Minnesota, USA).

Using this software, the majority of the parameters were quantified, while the others were measured manually. To assess the variables "Lip Competency at Rest" and "Visible Gingiva during Smile" in the patients' records.

Statistical analysis

Quantitative variables were reported as mean (standard deviation), while qualitative variables were presented as frequency (percentage). The normality of variable distributions was assessed using the Shapiro-Wilk test. In cases of abnormal distribution, Mann-Whitney test was employed, while for variables with normal distributions, independent t test was applied. Age and treatment duration were initially compared between the two groups (treatment with MSH and the twin block) using independent sample t-tests, and gender was compared using the Chi-Square test. This analysis demonstrated homogeneity across these variables. Subsequently, two groups were compared based on parameter values before treatment using independent sample t-tests or Mann-Whitney tests.

To compare post-treatment parameters, non-parametric Quade test and to compare the pre-treatment parameters the Mann-Whitney or independent sample t-test were utilized. Data were analyzed using SPSS software version 26, and a significance level of 5% was considered in all analyses.

Results

In the MSH group, there were 8 females (50%) and 8 males (50%). Similarly, in twin block group, there were 12 females (75%) and 4 males (25%), indicating that these two groups did not exhibit a significant difference in terms of gender ($p = 0.144$).

In (Table 1), the mean age of patients in the MSH group was 11.19 years (with a standard deviation of 1.90), while in the twin block group, it was 11.94 years (with a standard deviation of 1.34). The average duration of treatment in the MSH group was 10.06 years (with a standard deviation of 3.43), and in the functional group, it was 9.56 years (with a standard deviation of 2.96). Independent t test results indicate that these two groups did not show a significant difference in these two variables ($p = 0.208$ and $p = 0.663$, respectively).

Table 1. Comparing Age and Treatment Duration in Two Groups

	MSH	Twin block	Test statistic	*p-value**
	Mean (Standard Deviation)	Mean (Standard Deviation)		
Age	11.19 (1.90)	11.94 (1.34)	-1.28	0.208
Duration of Treatment	10.06 (3.43)	9.56 (2.96)	0.44	0.663

*** Independent t test**

The comparison of means and standard deviations of variables in two groups before undergoing treatment with MSH and twin block is presented in (Table 2). The comparison of the two groups for the assessed parameters reveals a significant difference in the "ANB" and "Lip Competency at rest" parameters, which were elevated in the MSH group ($p = 0.035$ and $p = 0.044$, respectively). The remaining examined parameters before treatment showed no significant difference between two groups ($p > 0.05$).

Table 2. Comparing Investigated Parameters before Treatment

Parameters	MSH	Twin block	Test statistic	P-value
	Mean (Standard Deviation)	Mean (Standard Deviation)		
SNA	82.90 (4.33)	80.15 (4.80)	94.00	0.210^{+}
SNB	75.66 (3.95)	74.16 (3.94)	1.07	0.292^{*}
ANB	7.23 (1.75)	5.99 (1.74)	72.50	0.035^{+}
Wits appraisal	4.10 (2.48)	4.00 (2.33)	0.11	0.913^{*}
Mandibular incisor to mandibular plane (L1/MP)	100.37 (9.82)	99.48 (9.20)	0.26	0.794^{*}
inter-incisal angulation (U1/L1)	116.17 (10.48)	119.95 (15.60)	137.50	0.724^{+}
Maxillary incisor to palatal plane (U1/PP)	114.83 (7.92)	113.12 (9.68)	129.50	0.956^{+}
Mandibular Length	103.76 (3.70)	102.37 (5.28)	0.860	0.397^{*}
Mandibular Body Length	68.48 (4.39)	67.98 (5.15)	0.29	0.770^{*}
Mandibular Base	70.15 (3.32)	69.25 (5.52)	0.56	0.578^{*}
Maxillary Length	46.30 (3.65)	44.15 (2.94)	1.83	0.770^{*}
Maxillary Base	72.87 (3.40)	71.28 (4.04)	1.20	0.238^{*}

Condylar Head	6.87 (2.14)	6.98 (2.91)	-0.118	0.907*
Ramus Length	53.80 (3.93)	53.41 (4.56)	116.50	0.669+
Molar Relation	0.43 (1.59)	-0.11 (1.84)	0.90	0.374*
overjet	7.21 (3.54)	6.37 (1.69)	0.86	0.399*
overbite	2.75 (2.39)	3.18 (2.24)	-0.533	0.598*
Maxillary Incisor	81.96 (4.82)	78.84 (5.10)	1.780	0.085*
Mandibular Incisor	74.96 (5.31)	72.37 (5.31)	1.380	0.178*
Maxillary Molar	48.84 (3.68)	48.90 (4.28)	-0.044	0.965*
Mandibular Molar	49.46 (4.06)	48.66 (5.02)	0.495	0.624*
SN to PP	8.16 (3.04)	9.45 (3.04)	154.00	0.341+
SN to MP	36.45 (7.44)	36.22 (5.90)	0.095	0.925*
Palatal-mandibular angle	28.61 (6.15)	27.45 (6.05)	0.539	0.594*
UFH/LFH	77.47 (6.20)	79.73 (9.58)	-0.79	0.434*
PFH/AFH	63.08 (5.19)	63.15 (4.83)	-0.035	0.972*
Nasolabial angle	98.49 (12.03)	107.06 (14.14)	-1.84	0.075*
Mentolabial Angle	112.09 (22.42)	115.71 (12.77)	-0.56	0.578*
Upper Lip to E-Line	-0.23 (1.97)	-0.91 (1.98)	0.98	0.334*
Lower Lip to E-Line	2.23 (2.59)	0.60 (1.97)	1.99	0.55*
Lip Competency at Rest	4.46 (3.22)	2.29 (2.43)	2.14	0.040*
Visible Gingiva during Smile	-1.00 (2.32)	-2.21 (1.64)	1.70	0.099*
Soft Tissue Convexity	127.06 (3.62)	127.95 (5.62)	-0.52	0.602*

+ Mann-Whitney test, * Independent t test

The mean values, standard deviations, and the results of statistical tests to compare the variables in two groups after treatment with MSH and Twin block are presented in (Table 3). No significant differences were observed between the two groups for any of the variables (*p-value* > 0.05).

Table 3. Comparison of the investigated parameters after treatment

Parameters	**MSH**	**Twin block**	**Test statistic**	**P-value**
	Mean (Standard Deviation)	Mean (Standard Deviation)		
SNA	82.69 (3.90)	79.68 (4.42)	2.04	0.050*
SNB	76.44 (4.01)	74.41 (4.01)	1.43	0.162*
ANB	6.29 (1.84)	5.20 (1.83)	119.00	0.752×
Wits appraisal	2.90 (2.36)	2.73 (2.22)	0.20	0.837*

Mandibular incisor to mandibular plane (L1/MP)	101.21 (8.71)	99.42 (8.35)	115.50	0.642⁺
inter-incisal angulation (U1/L1)	118.55 (12.90)	122.31 (11.64)	-0.86	0.393*
Maxillary incisor to palatal plane (U1/PP)	112.63 (9.94)	111.88 (7.91)	0.236	0.815*
Mandibular Length	105.48 (5.12)	103.81 (6.68)	0.79	0.436*
Mandibular Body Length	71.20 (4.45)	68.71 (5.51)	77.50	0.056⁺
Mandibular Base	71.81 (3.21)	70.25 (5.63)	0.96	0.343*
Maxillary Length	45.74 (3.15)	45.24 (3.84)	0.40	0.690*
Maxillary Base	73.21 (2.60)	71.15 (4.35)	1.57	0.125*
Condylar Head	6.34 (2.71)	6.60 (4.35)	-0.204	0.839*
Ramus Length	54.34 (4.07)	54.56 (5.14)	-0.13	0.892*
Molar Relation	1.51 (2.48)	1.82 (2.30)	138.00	0.724⁺
overjet	4.41 (1.88)	4.40 (2.34)	0.01	0.987*
overbite	2.43 (1.63)	2.31 (2.20)	0.18	0.857*
Maxillary Incisor	81.06 (3.65)	78.18 (4.95)	1.86	0.072*
Mandibular Incisor	76.62 (3.73)	73.68 (6.14)	1.63	0.112*
Maxillary Molar	50.12 (3.68)	49.09 (4.97)	0.66	0.510*
Mandibular Molar	52.20 (3.65)	50.97 (5.73)	0.72	0.475*
SN to PP	8.46 (3.32)	9.35 (2.62)	-0.83	0.409*
SN to MP	35.88 (7.00)	35.41 (5.78)	0.209	0.836*
Palatal-mandibular angle	27.57 (6.72)	26.38 (5.44)	0.54	0.587*
UFH/LFH	76.13 (6.28)	80.42 (8.07)	-1.67	0.104*
PFH/AFH	63.15 (4.88)	63.99 (4.59)	-0.50	0.619*
Nasolabial angle	102.60 (17.14)	107.95 (10.09)	-1.07	0.290*
Mentolabial Angle	119.21 (16.27)	118.65 (19.32)	0.08	0.930*
Upper Lip to E-Line	-0.73 (2.45)	-1.81 (1.68)	1.46	0.154*
Lower Lip to E-Line	2.35 (2.46)	0.74 (2.74)	1.74	0.092*
Lip Competency at Rest	3.04 (3.40)	2.29 (2.77)	81.50	0.270$^{\times}$

Visible Gingiva during Smile	-0.75 (1.43)	-1.33 (2.33)	1.84	0.077*
Soft Tissue Convexity	126.81 (4.43)	126.99 (4.25)	-0.118	0.907*

+ Mann-Whitney test
*** Independent *t* test**
× Quade test

Discussion

16 records of patients treated with MSH and another 16 treated with the twin block, meeting specific inclusion and exclusion criteria, were selected. The average age of patients in the MSH group was 11.19 years, with a mean treatment length of 10.06 months, while the twin block group had an average age of 11.94 years and a mean treatment time of 9.56 months.Statistical analyses showed no significant gender-based differences between two treatment groups, and their treatment outcomes were similar. Comparing mean values of examined parameters before treatment showed no significant differences except for ANB parameter and Lip Competency at Rest. However, post-treatment analyses, including the non-parametric Quade test for ANB parameter and Lip Competency at Rest parameters, indicated no significant differences.

These findings indicate that the assessment of indicators before and after treatment between the MSH and twin block groups did not vary significantly. The outcomes of these two treatments were found to be similar. The clinical implications of these findings may affect orthodontic practice and guide future research in this field.

Miguel *et al*. conducted a study on Class II patients undergoing orthodontic treatment with MSH and Cervical Headgear, reporting a significant reduction in overjet and substantial uprighting of maxillary incisors with MSH compared to Cervical Headgear. Similarly, in our study, MSH showed a greater reduction in overjet, aligning with Miguel *et al*.'s findings (10).

Omidkhoda *et al*. compared the skeletal and dental effects of Thurow and Activator appliances in patients with Class II malocclusion. Our analysis, consistent with the findings of Omidkhoda *et al*., identified a statistically significant difference in the mean of L1-MP between these appliances post-treatment (P=0.007), but no significant variations were seen in other variables (12) .In a review study by Kallunki *et al*., early treatment of Class II malocclusion with functional appliances was found to reduce overjet and improve skeletal relationships. However, our study did not find a statistically significant difference in overjet reduction between functional and headgear groups, possibly due to the variations in headgear types used (9).

Keeling *et al*., similar to our study, found out that MSH corrected Class II molar relationships and reduced overjet, with movement of the posterior upper teeth. Although their study revealed a notable distinction between the control group and the functional and headgear groups, our study did not identify a statistically significant difference between the functional and headgear groups, aligning with the sample sizes and methodologies employed in both studies (13). In a study by Martins *et al*. (14) involving 51 Class II patients across three groups, including a control group, Bionator, and Removable Headgear Splint (RHS), both devices primarily improved front-to-back molar relationships via alveolar dental changes. Overjet significantly improved in both devices compared to the control group, with Bionator impacting forward movement of lower jaw and RHS leading to backward movement. Similarly, our study found no statistically significant difference between two functional and headgear devices, possibly due to the similarities in sample size and treatment methods.

Haralabakis *et al*. categorized Class II patients into two cohorts: one received treatment with a modified Activator-type functional appliance, while the other was treated with a combination of cervical headgear and fixed Edgewise appliances. Only significant difference observed in their study was a significant reduction in the SNA angle in the headgear group, indicating changes in front-to-back dimension. The headgear group's lower jaw moved nearly 1 millimeter more forward, as evidenced by the evaluation of skeletal changes in the lower jaw. This finding is consistent with our study, which compared functional appliances with headgear splints, and found no statistically significant difference between the treatment groups (15). The limitations of this study included the time-consuming process of identifying samples that met the study's inclusion criteria, and the lack of information regarding patient compliance with the device used and the duration of device usage throughout the day.

Conclusion

In conclusion, given the previous studies, both MSH and Twin block are effective in treating Class II malocclusion (10). Considering present limitations and based on obtained statistical results, the effects of these two devices did not show a significant difference to improve cephalometric evaluation indices. Additionally, age and gender did not significantly impact the differences in the results of these two treatment methods.

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Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethics approval and consent to participate

The current study was based on a student thesis accepted by Zanjan University of Medical Sciences with ethics code IR.ZUMS.REC.1400.458, which was implemented in partnership with Shahid Beheshti University of Medical Sciences.

Authors' Contribution

Design of the work and Conceptualization: A.N. and H.S.; Data Collection: S.S. and A.D.S. and H.S.; Data Analysis: F.A.; original draft preparation, S.M.; Review and Editing: A.N. and S.M.; Critical revision of the article: A.N.; Supervision: A.N.

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