RESEARCH ARTICLE

A Comparative Evaluation of the Dentoskeletal Treatment Effects Using Twin Block Appliance and Myobrace System on Class II Division I Malocclusion

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Abstract

The study aimed to evaluate the dentoskeletal effects of twin block appliance and myobrace system in treating skeletal Class II Division I malocclusions in growing children taking into account the effects of normal growth in an untreated control group. Twenty subjects with Class II Division I malocclusion considered as study group were allocated randomly to two treatment groups of 10 each, consecutively treated with twin block appliances (mean age 10.850 $\pm$ 1.37 years) and myobrace system (mean age 10.40 $\pm$ 1.89 years). Ten children (mean age 10.60 $\pm$ 1.77 years) with untreated Class II Division I malocclusion were considered as a control group to eliminate possible growth effects. At the start of the treatment and end of the observation period of 18–24 months, lateral cephalograms were taken. All the angular and linear parameters measured were subjected to statistical analysis. Twin block group subjects produced more measurable and statistically significant skeletal and dentoalveolar changes at the end of the observation period, demonstrated by correction of full cuspal Class II molar relationship to Class I molar relationship and yielding mandibular growth in increments greater in magnitude than the myobrace system. Meanwhile, the myobrace system-induced favorable dentoalveolar changes by a significant reduction of overjet. The retrognathic profile, however, improved in both the intervention groups as the upper lip protrusion, mentalis strain, and the lower lip curl were eliminated in striking contrast to the untreated control group. The study demonstrates that with appropriate patient selection both myobrace system and twin block appliances can be used in conjunction with the fixed appliance therapy to achieve more stable Class II corrections.

Keywords: Class II malocclusion, Myobrace system, Myofunctional, Twin block.

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Introduction

The Tweed years focused on early orthodontic treatment (EOT), wherein treatment coped up with active growth or utilized its dynamics therein. Tweed and his contemporaries discovered that interception of dentofacial deformities using "growth and its potentials" and biological principles at the sensitive childhood period was more rewarding and exhilarating than the harsh mechanics employed in the multibonded fixed appliance therapy as the former took advantage of the growth of the child in achieving the goal of occlusal harmony, function, and dental-facial esthetics.[1,2]

The American Academy of Paediatric Dentistry recommends that children should be amenable to early screening for developing malocclusions, as many conditions are easier to treat at an early stage when children's natural growth processes are intense. Early intervention facilitates normal future growth and development by modification of aberrant muscle morphology, elimination of abusive oral habits, improvement of facial esthetics, self-esteem, and most importantly avoids or decreases the possibility for aggressive fixed mechanotherapy with multiple extractions or even the later probability of needing an orthognathic surgery.[3]

McNamara[4] claimed mandibular retrognathism as the most frequent skeletal problem in Class II malocclusions during preadolescence. It is a known fact that Class II dentoskeletal disharmony does not tend to self-correct with growth if left untreated and may lead to worsening of total mandibular length deficiency and mandibular ramus height.[5] This led to the innovation of functional appliances which tend to anteriorly position the mandible to stimulate significant mandibular growth primarily by enhancing remodeling response at the condyle.[6,7] Of the many functional appliances that were innovated and tried, twin block and more recently, myobrace system gained popularity in the correction of Class II Division I malocclusions in growing children by producing significant changes in oral function simulating the mandibular growth. So the present study aims at finding the efficacy of both twin block and myobrace system in the correction of Class II Division I malocclusion in growing children by cephalometrically evaluating the skeletal and dentoalveolar changes therein after active functional appliance therapy.

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Materials and Methods

The study was approved by the Ethical Committee of KVG Dental College and Hospital, Sullia, Karnataka, India. Informed consent was obtained from all the parents of the subjects included in this study after explaining the treatment protocols.

Thirty children were included in the study according to the following criteria:

- Class II skeletal malocclusion with the orthognathic maxilla and retrognathic mandible.
- Mean age 10 ± 3.4 years.
- Positive visual treatment objective (VTO).
- ANB angle >4°.
- Average to the horizontal growth pattern.
- Overjet >6 mm.

Study participants were divided into 3 groups with 10 children in each group. Group I included children treated with twin block group with mean age 10.850 ± 1.37 years, group II included children treated with myobrace system (K series, Myofunctional Research Co, Australia) with mean age 10.40 ± 1.89 years, group III included children who were not willing to undergo removable functional appliance therapy and insisted on fixed appliance therapy by braces in the future and were untreated for mentioned malocclusion but visited the hospital for other routine dental treatments with mean age 10.60 ± 1.77 years. All the children were followed up for a period of 18–24 months.

Subjects with any of these following criteria were excluded from the study group:

- Medically compromised patients.
- Cases with congenital syndromes.
- Cases with obvious asymmetry especially prognathic maxilla.
- Patient with prior appliance therapy.
- Vertical growth pattern.
- Patients with TMJ problems and ankylosis.
- Cases with severe proclination of maxillary or mandibular anteriors.
- Cases with overjet >10 mm due to combined effect of mandibular dental retroclination and severe maxillary dental proclination.

Cephalometric analysis was performed on lateral cephalometric radiographs taken at the start and end of appliance therapy. For standardization purposes, all lateral cephalograms were taken from the same cephalostat machine on a standard Kodak C-MAT Green Sensitive 8 × 10-inch film with the anode to mid subject distance of 5 feet and F–H plane parallel to the floor and lips in repose with centric occlusion. Tracing of all the radiographs was done on matte acetate tracing paper in random order by a single investigator using a 3HB pencil to reduce bias. All the angular and linear parameters of pre- and posttreatment cephalograms were measured. Twenty-four landmarks were identified on each radiograph and grouped into angular skeletal, linear skeletal, and dental measurements.

Angular skeletal measurements were Sella-Nasion-Point A (SNA/maxilla) angle, Sella Nasion Point B (SNB/mandible) angle, Point A–Nasion–Point B (ANB/relation between maxilla and mandible) angle, Nasion point A–Pogonion (Angle of convexity)/ (Na–Pog), Sella–Nasion–Articulare (SN–Ar), Sella–Articulare-Gonion (S–Ar–Go), Articulare–Gonion–Gnathion (Ar–Go–Gn), Occlusal plane-Sella Nasion (OP–SN), Occlusal plane Mandibular plane (OP–MP). Linear skeletal measurements included were Gonion-Gnathion (Go–Gn), Gnathion–Articulare (Gn–Ar), Gonion–Menton (Go–Me), Nasion-Menton (N–Me), Sella–Gonion (S–Go). Dental measurements included upper incisor to NA (distance and angle), lower incisor to NB (distance and angle), incisor mandibular plane angle (IMPA), Overjet (mm), Overbite (mm), maxillary 1st molar position, mandibular 1st molar position.

Appliance Design

Twin Block Appliance

Comprised of maxillary and mandibular appliances that fit tightly against the teeth, alveolus, and adjacent supporting structures. Adams clasps were used bilaterally to anchor them to the first permanent molars. In addition, for retention purposes, a short passive labial bow was added to the upper arch and 0.030-inch ball end clasps to the interproximal areas of the lower arch. Initialwax construction bite registration was made with the mandible protracted approximately 6 mm and opened vertically with the blocks 4 mm apart in the buccal segments. The steep inclined planes interlocked at about 70° to the occlusal plane. In patients with slight asymmetry of the mandible, an effort is made to correct the asymmetry by encouraging differential growth of the mandible by recording the construction bite with the upper and lower midlines coinciding. As the treatment progressed, reactivation of the blocks was carried out as and when required after 4–5 months of therapy. For maintaining sufficient activation of the jaw muscles especially the lateral pterygoids, 1.5–2 mm acrylic was added to the distal inclines of the lower appliance bite shelves as soon as 3–4 mm of overjet reduction was achieved. The subjects were instructed to wear the appliance 24 hours/day. Regular follow-ups were done during the course of the treatment and progress was charted out.

Myobrace System

Myobrace system for kids (K1, K2, K3), a three-stage appliance system was used for this study (Myofunctional Research Co, Queensland, Australia) as per the manufacturer's instructions. K1 made of flexible silicone aided in adapting diverse arch forms and poorly aligned teeth. K2 with its Frankel cage helped in the development of the arch form and improved the dental alignment. K3 was used for the final alignment and retention of the arch. K1 was used for a period of 6–8 months and followed by K2 until satisfactory results were obtained. K3 appliance was given as retention and finishing appliance. Patients were followed up for the time period of 18–24 months. Subjects were encouraged to wear the trainer every day for 1–2 hours during the day and 10–12 hours at night during sleep. Myofunctional exercises like swallowing by keeping the appliance in the mouth with lips pursed and tongue tip positioned on tongue tag were advised. Since the compliance of the patient was of prime importance during the treatment period, a follow-up chart was prepared and monitored periodically.

Statistical Analysis

The data collected were entered into a Microsoft Excel spreadsheet and analyzed using Statistical Package for Social Sciences (*SPSS*) *version* 17 (SPSS Inc. California, USA). Descriptive data were presented in the form of frequencies, percentages, mean, and standard deviation. Analysis of variance (ANOVA) with Bonferroni *post hoc* test was used to compare the variables among the three study groups to obtain the pre- and posttreatment equivalence. The difference between cephalometric pretreatment and post-treatment measurements was statistically analyzed using the Student's paired *t*-test. p value < 0.05 was considered statistically significant. The significance of the *p* value was determined at 0.05*, 0.01**, and 0.001*** levels of confidence. The nonparametric Mann–Whitney *U* test was used to detect the intergroup differences after being subject to the Kruskal–Wallis Chi-square test and was chosen as the data was nonhomogeneous and may not have been normally distributed.

Results

The results can be grouped under the following titles:

- Comparison of study parameters in the control group at the start and end of the observation period.
- Comparison between pre- and posttreatment changes in the twin block group.
- Comparison between pre- and posttreatment changes in the myobrace group.
- Intergroup comparison of postobservation period changes between twin block, myobrace, and control groups.

Comparison of Study Parameters at the Start and End of Observation Period in the Control Group (Table 1)

There was a negligible improvement in SNA, SNB, and ANB angles with a statistically nonsignificant mean decrease of SNA by 0.01° ($p = 0.961$), mean increase of SNB by 0.30° ($p = 0.025$) which was a statistically significant and mean decrease of ANB by 0.21° ($p = 0.386$). Facial convexity angle used as a marker to measure the overall profile change, increased by 0.15° which was nonsignificant ($p = 0.541$). Facial growth type determined by the mandibular plane angle (SN–GoGn) increased nonsignificantly by 0.34° ($p = 0.178$) and Bjork's polygon angles, referred to as the sum of Saddle angle (N–S–Ar), Articulare angle (S–Ar–Go), and Gonial angle (Ar–Go–Me) showed a mean decrease of 0.42°. Maxillomandibular plane angle (PP–MP) showed a decrease in the base plane by 0.47° ($p = 0.002$) and was statistically significant. The mean decrease in the cant of the occlusal plane (OP–SN) was 0.71° ($p = 0.035$) which was statistically nonsignificant. Linear skeletal changes showed an increase in anterior facial height (N–Me) and posterior facial height (S–Go) by 0.65 mm ($p = 0.001$) and 0.43 mm ($p = 0.001$), respectively, which was statistically significant. Linear measurements of mandible determined by Ramal height (Go–Ar) was increased by 0.48 mm ($p = 0.005$) which was statistically significant, mandibular body length (Go–Me) showed a nonsignificant increase of 0.50 mm (p = 0.052), and mandibular base length, measured from Ar–Gn showed a nonsignificant increase by 0.20 mm. Dentoalveolar change in the maxilla was measured using a variable "maxillary incisal angle" determined by the inclination of upper incisors relative to the palatal plane (ANS–PNS) increased by 0.54° ($p = 0.053$) and 0.26 mm ($p = 0.036$). Overjet increased by 0.19 mm and is statistically nonsignificant ($p = 0.616$). The position of lower incisors showed only a nonsignificant increase of 0.35° ($p = 0.136$) and 0.24 mm ($p = 0.047$). Mesial migration of both upper and lower molars was negligible by 0.33 mm ($p = 0.152$) and 0.45 mm ($p = 0.041$), respectively.

Comparison between the Pre- and Posttreatment Changes in Twin Block Group (Table 2)

Mean decrease in SNA angle was 0.30° ($p = 0.081$), SNB angle increased significantly by 2° ($p = 0.001$), and ANB angle showed

Table 1: Comparison of study parameters at start and end of the observation period in the control group

	Control-before	*Control-after*	*Mean difference (SD)*	*t*	*df*	*p value*
SNA	80.00 (3.49)	79.99 (3.70)	0.01 (0.63)	0.050	9	0.961
SNB	74.14 (3.77)	74.44 (3.61)	−0.30 (0.35)	−2.689	9	0.025*
ANB	5.86 (2.17)	5.65 (1.55)	0.21 (0.72)	0.910	9	0.386
NA–Pog	5.80 (2.34)	5.65 (2.02)	0.15 (0.74)	0.635	9	0.541
SN–Go–Gn	30.43 (8.01)	30.09 (8.04)	0.34 (0.73)	1.460	9	0.178
PP–MP	23.89 (6.41)	23.42 (6.43)	0.47 (0.34)	4.370	9	0.002*
OP–SN	20.53 (3.53)	19.82 (3.90)	0.71 (0.90)	2.478	9	0.035*
S–Ar–Go	137.50 (5.71)	137.05 (5.59)	0.45 (0.36)	3.857	9	0.004*
N–S–Ar	128.27 (5.13)	128.89 (5.01)	−0.62 (0.42)	−4.571	9	0.001*
Ar–Go–Me	126.30 (6.83)	125.71 (6.92)	0.59 (0.66)	2.817	9	0.020*
Ar–Gn	99.250 (9.022)	99.45 (8.95)	−0.20 (0.34)	−1.809	9	0.104
N–Me	109.45 (6.42)	110.10 (6.22)	−0.65 (0.41)	−4.993	9	0.001*
S–Go	72.40 (6.21)	72.83 (6.19)	−0.43 (0.28)	−4.739	9	0.001*
Go–Ar	41.80 (5.97)	42.28 (5.81)	−0.48 (0.41)	−3.674	9	0.005*
Go–Me	64.30 (3.59)	64.80 (3.11)	−0.50 (0.70)	−2.236	9	0.052
U1–NA (deg)	31.60 (6.31)	32.14 (6.45)	−0.54 (0.76)	−2.224	9	0.053
U1–NA (mm)	10.20 (2.93)	10.46 (2.91)	−0.26 (0.33)	−2.462	9	0.036*
U1–SN	109.00 (7.18)	108.65 (7.82)	0.35 (10.05)	1.049	9	0.322
L1–NB (deg)	32.20 (4.49)	31.85 (4.36)	0.35 (0.67)	1.639	9	0.136
L1–NB (mm)	8.15 (1.82)	7.91 (1.76)	0.24 (0.33)	2.295	9	0.047*
IMPA	105.90 (7.89)	105.57 (8.06)	0.33 (1.12)	0.926	9	0.378
OVERBITE	3.60 (1.50)	3.94 (1.50)	−0.34 (0.47)	−2.279	9	0.049*
OVERJET	8.40 (1.89)	8.59 (2.27)	−0.19 (1.15)	−0.519	9	0.616
U6 (mm)	48.80 (7.62)	49.13 (7.74)	−0.33 (0.66)	−1.565	9	0.152
L6 (mm)	46.70 (9.00)	47.15 (9.01)	−0.45 (0.59)	−2.377	9	0.041*

* Statistically significant

****** Statistically non-significant

Table 2: Comparison of study parameters in TB group before and after intervention

	TB-before	*TB-after*	*Mean difference (SD)*	*t*	*df*	*p value*
SNA	79.60 (2.54)	79.30 (2.79)	0.30 (0.48)	1.964	9	0.081
SNB	73.50 (1.77)	75.50 (2.41)	−2.00 (1.33)	−4.743	9	0.001*
ANB	6.10 (2.02)	3.90 (1.72)	2.20 (1.22)	5.659	9	0.000*
NA–Pog	5.95 (1.64)	4.05 (1.64)	1.90 (0.99)	6.042	9	0.000*
SN–Go–Gn	31.15 (5.98)	31.33 (5.74)	−0.18 (0.49)	−1.147	9	0.281
PP–MP	24.80 (6.28)	24.43 (6.01)	0.37 (0.70)	1.669	9	0.129
OP–SN	21.00 (2.46)	21.13 (2.57)	−0.13 (0.63)	−0.648	9	0.533
S–Ar–Go	141.10 (2.64)	139.00 (5.14)	2.10 (3.31)	2.003	9	0.076
N–S–Ar	124.15 (3.28)	122.68 (4.11)	1.47 (1.71)	2.705	9	0.024*
Ar–Go–Me	129.25 (5.63)	129.95 (5.60)	−0.70 (0.71)	−3.096	9	0.013*
Ar–Gn	94.70 (7.18)	99.30 (9.36)	−4.60 (4.56)	−3.184	9	0.011*
N–Me	109.00 (6.48)	112.80 (5.88)	−3.80 (3.26)	−3.677	9	0.005*
S–Go	68.90 (5.32)	72.35 (6.54)	−3.45 (1.95)	−5.595	9	0.000*
Go–Ar	39.50 (3.20)	42.55 (4.24)	−3.05 (2.03)	−4.742	9	0.001*
Go–Me	61.00 (6.39)	64.90 (4.97)	−3.90 (2.95)	−4.179	9	0.002*
U1–NA (deg)	32.95 (5.32)	23.50 (4.81)	9.45 (4.69)	6.368	9	0.000*
U1–NA (mm)	9.10 (1.71)	6.35 (1.59)	2.75 (1.70)	5.104	9	0.001*
U1–SN	110.00 (16.17)	98.40 (12.26)	11.60 (13.14)	2.791	9	0.021*
L1–NB (deg)	27.65 (8.45)	31.10 (9.43)	−3.45 (3.29)	−3.311	9	0.009*
L1–NB (mm)	11.25 (10.62)	12.30 (10.58)	−1.05 (1.18)	−2.792	9	0.021*
IMPA	105.25 (7.18)	109.25 (6.11)	−4.00 (3.92)	−3.224	9	0.010*
OVERBITE	4.20 (1.47)	2.95 (1.11)	1.25 (1.03)	3.822	9	0.004*
OVERJET	8.60 (2.59)	3.50 (1.26)	5.10 (3.07)	5.251	9	0.001*
U6 (mm)	45.90 (10.43)	48.40 (9.63)	−2.50 (6.96)	−1.136	9	0.285
L6 (mm)	43.95 (11.15)	51.45 (10.59)	−7.50 (7.42)	−3.195	9	0.011*

highly statistically significant reduction by 2.20° ($p = 0.000$). Facial convexity angle increased notably by 1.90° ($p = 0.000$). The mandibular plane angle increased by 0.18° which was statistically nonsignificant ($p = 0.281$). The maxillomandibular plane angle (PP–MP) showed a nonsignificant decrease in the base plane angle by 0.37° ($p = 0.129$). Cant of the occlusal plane (OP–SN) increased by 0.13° which was statistically nonsignificant ($p = 0.533$). Bjork's polygon angles showed a mean decrease of 2.87°. Linear skeletal changes showed an increase in anterior facial height (N–Me) and posterior facial height (S–Go) by 3.80 mm ($p = 0.005$) and 3.45 mm ($p = 0.000$), respectively, which was statistically significant. Linear measurements of mandible showed significantly increase in Ramal height (Go–Ar), mandibular body length (Go–Me), and mandibular base length (Ar–Gn) by 3.05 mm ($p = 0.001$), 3.90 mm ($p = 0.002$), and 4.60 mm ($p = 0.011$), respectively. The mean reduction in the proclination of the upper incisor in terms of angular and linear skeletal measurements was 9.45° ($p = 0.000$) and 2.75 mm ($p = 0.001$), respectively. Overjet reduced by 5.10 mm which is statistically very highly significant ($p = 0.001$). There was statistically significant proclination of the lower incisor in relation to the mandibular plane by 3.45° and 1 mm. The lower molar moved more mesially by 7.50 mm ($p = 0.011$) adding to the correction of full cusp Class II molar relationship to Class I molar relation.

Comparison between the Pre- and Posttreatment Changes in the Myobrace Group (Table 3)

Mean decrease in SNA angle was 0.09° ($p = 0.661$), SNB angle increased significantly by 1.35° ($p = 0.002$), and ANB angle showed highly statistically significant reduction by 2.705° ($p = 0.024$). Facial convexity angle increased notably by 1.37° ($p = 0.008$). The cant of the occlusal plane (OP–SN) was significantly reduced in the myobrace group by 0.88° ($p = 0.002$). Mandibular plane angle significantly decreased by 0.70° ($p = 0.034$). The maxillomandibular plane angle (PP–MP), showed a statistically significant decrease in the base plane angle by 0.70° ($p = 0.001$). Bjork's polygon angles showed a mean decrease of 0.83° which was statistically significant. Linear measurements of mandible showed significantly increase in Ramal height (Go–Ar), mandibular body length (Go–Me), and mandibular base length (Ar–Gn) by 1.40 mm ($p = 0.003$), 1.75 mm ($p = 0.000$), and 1.55 mm ($p = 0.000$), respectively. Linear skeletal changes showed an increase in anterior facial height (N–Me) and posterior facial height (S–Go) by 3.25 mm ($p = 0.18$) and 1.49 mm ($p = 0.18$), respectively, which was statistically significant. The mean reduction in the proclination of the upper incisor was 4.25° ($p = 0.000$) in terms of angular measurements and 2.65 mm ($p = 0.001$) in terms of linear skeletal measurement which is statistically significant. Overjet reduced significantly by 3.55 mm ($p = 0.002$). There was statistically significant proclination of the lower incisor in relation to the mandibular plane by 3.60° and 0.75 mm. Mesial migration of both upper and lower molars occurred by 0.95 and 1.90 mm, respectively, and their relationship seemed static.

Intergroup Comparison of Post-observation Period Changes between the Twin Block, Myobrace, and Control Groups (Table 4)

Differences between the study groups on SNA, SNB, and ANB were statistically nonsignificant with p value 0.489, 0.176, and 0.053, respectively. Improvement in facial convexity angle was better in

Table 3: Comparison of study parameters in myobrace group before and after intervention

	Myobrace-before	*Myobrace-after*	*Mean difference (SD)*	*t*	*df*	*p value*
SNA	79.80 (2.09)	79.71 (1.90)	0.09 (0.62)	0.453	9	0.661
SNB	74.15 (2.10)	75.50 (2.62)	−1.35 (0.97)	−4.386	9	0.002*
ANB	5.75 (1.62)	4.61 (1.23)	1.14 (1.33)	2.705	9	0.024*
NA–Pog	5.77 (1.87)	4.40 (1.24)	1.37 (1.27)	3.411	9	0.008*
SN–Go–Gn	31.45 (3.91)	30.75 (3.75)	0.70 (0.88)	2.492	9	0.034*
PP–MP	24.10 (1.72)	23.40 (1.50)	0.70 (0.48)	4.583	9	0.001*
OP–SN	22.35 (3.18)	21.47 (3.39)	0.88 (0.63)	4.402	9	0.002*
S–Ar–Go	143.40 (4.55)	142.72 (4.51)	0.68 (0.60)	3.564	9	0.006*
N–S–Ar	124.35 (3.36)	124.82 (3.33)	−0.47 (0.14)	−10.48	9	0.000*
Ar–Go–Me	126.00 (4.52)	125.38 (4.45)	0.62 (0.75)	2.59	9	0.029*
Ar–Gn	93.20 (5.59)	94.75 (5.82)	−1.55 (0.76)	−6.433	9	0.000*
N–Me	106.30 (5.67)	109.55 (6.34)	−3.25 (3.54)	−2.899	9	0.018*
S–Go	67.60 (4.29)	69.09 (4.75)	−1.49 (1.64)	−2.873	9	0.018*
Go–Ar	39.45 (3.57)	40.85 (4.22)	−1.40 (1.12)	−3.934	9	0.003*
Go–Me	61.50 (5.06)	63.25 (4.66)	−1.75 (0.97)	−5.653	9	0.000*
U1–NA (deg)	30.60 (7.96)	26.40 (7.35)	4.20 (2.29)	5.775	9	0.000*
U1–NA (mm)	8.95 (2.51)	6.30 (1.54)	2.65 (1.79)	4.666	9	0.001*
U1–SN	109.25 (9.12)	105.40 (9.89)	3.85 (3.03)	4.008	9	0.003*
L1–NB (deg)	30.15 (8.13)	33.75 (8.59)	−3.60 (2.57)	−4.413	9	0.002*
L1–NB (mm)	6.80 (2.29)	7.55 (2.34)	−0.75 (1.05)	−2.243	9	0.052
IMPA	105.80 (9.40)	109.10 (8.69)	−3.30 (2.05)	−5.072	9	0.001*
OVERBITE	3.63 (1.40)	3.55 (.86)	0.08 (1.17)	0.216	9	0.834
OVERJET	7.80 (2.78)	4.25 (1.11)	3.55 (2.59)	4.322	9	0.002*
U6 (mm)	44.70 (8.60)	43.75 (8.08)	0.95 (5.98)	0.502	9	0.628
L6 (mm)	43.10 (8.82)	45.00 (8.36)	−1.90 (6.11)	−0.983	9	0.351

* Statistically significant

the twin block group when compared to the myobrace group but it was statically nonsignificant ($p = 0.156$). Statistically significant improvement occurred in mandibular plane angle (SN–GoGn) in the myobrace group when compared to the twin block group ($p = 0.026$). The cant of the occlusal plane (OP–SN) was significantly reduced in the myobrace group when compared to the control group ($p = 0.005$). Myobrace showed a better decrease in maxillomandibular plane angle (PP–MP) when compared to the twin block group, but the difference was not statistically significant ($p = 0.051$). The twin block group showed a better decrease in Bjork's polygon angles when compared to the myobrace group with statistically significant differences on Articulare angle (S–Ar–Go) ($p < 0.001$) and Gonial angle (Ar–Go–Me) ($p = 0.002$). Ramal height (Go–Ar) was increased significantly in the twin block group compared to the myobrace group and the difference of their effect was statistically significant ($p = 0.037$). The increase in mandibular body length (Go–Me) was more in the twin block group when compared to the myobrace group and the difference was statistically nonsignificant ($p = 0.107$). An increase in mandibular base length (Ar–Gn) was significant in the twin group compared to the myobrace group and the difference was statistically significant ($p = 0.037$). An increase in the anterior facial height (N–Me) was more in the twin block group compared to the myobrace group and the difference was nonsignificant statistically. An increase in the posterior facial height (S–Go), was more in the twin block group compared to the myobrace group and the difference was significant statistically ($p = 0.018$). Mean reduction in proclination of upper incisors in terms of angular measurements was statistically and clinically significant in the twin block group compared to the myobrace group ($p = 0.009$); whereas in terms of angular measurements the difference was not statistically significant ($p = 0.620$). Both twin block and myobrace groups resulted in a statistically significant reduction in overjet, in which the former group was better compared to the latter and the difference was statistically nonsignificant ($p = 0.148$). After twin block and myobrace treatment, there was statistically significant proclination of lower incisor in relation to the mandibular plane but the difference between the study groups was statistically nonsignificant ($p = 0.731$). In the twin block group, the upper and lower molars moved more mesially compared to the myobrace group and the difference between the groups was statistically nonsignificant ($p = 0.761$ and 0.097), respectively.

Discussion

Twin block appliances prompt additional lengthening of the mandible by instigating increased growth at the condylar cartilage when constructed to a protrusive bite with the occlusal inclined plane as a guiding mechanism and closes the mandible forward. The myobrace system meanwhile, drives the craniofacial system of muscles to a physiological load of bones and stimulates growth and development of their structures including the correct teeth positioning. As a result, the masticatory and facial muscles start to work efficiently and the forces between the tongue and cheek attain an equilibrium due to the proper tongue position both in function and rest. The appliances brought about considerable changes which were quantified by angular and linear measurements, thereby

Table 4: Comparison of study parameters between TB, myobrace, and control groups after intervention using Kruskal–Wallis test

	Study groups					*Post hoc test–p value*		
	TB	*Control*	*Myobrace*	*Kruskal–Wallis Chi-square*	*p value*	*TB vs control*	*Control vs myobrace*	*TB vs myobrace*
SNA	0.30 (0.48)	0.01 (0.63)	0.09 (0.62)	0.787	0.675 (NS)	0.391 (NS)	0.875 (NS)	0.489 (NS)
SNB	−2.00 (1.33)	−0.30 (0.35)	−1.35 (0.97)	15.33	<0.001*	0.002*	0.001*	0.176 (NS)
ANB	2.20 (1.22)	0.21 (0.72)	1.14 (1.33)	11.975	0.003*	0.001*	0.101 (NS)	0.053 (NS)
NA–Pog	1.90 (0.99)	−0.15 (0.74)	1.37 (1.27)	13.092	0.001*	0.001*	0.017*	0.156 (NS)
SN–Go–Gn	−0.18 (0.49)	0.34 (0.73)	0.70 (0.88)	6.574	0.037*	0.036*	0.421 (NS)	0.026*
PP–MP	0.37 (0.70)	0.47 (0.34)	0.70 (0.48)	4.452	0.108 (NS)	0.312 (NS)	0.146 (NS)	0.051 (NS)
OP–SN	−0.13 (0.63)	0.71 (0.90)	0.88 (0.63)	9.539	0.008*	0.023*	0.324 (NS)	0.005*
S–Ar–Go	2.10 (3.31)	0.45 (0.36)	0.68 (0.60)	4.043	0.132 (NS)	0.048*	0.346 (NS)	0.262 (NS)
N–S–Ar	1.47 (1.71)	−0.62 (0.42)	−0.47 (0.14)	19.149	<0.001*	<0.001*	0.416 (NS)	<0.001*
Ar–Go–Me	−0.70 (0.71)	0.59 (0.66)	0.62 (0.75)	12.903	0.002*	0.002*	0.701 (NS)	0.002*
N–Me	−3.80 (3.26)	−0.65 (0.41)	−3.25 (3.54)	11.337	0.003*	0.002*	0.013*	0.362 (NS)
S–Go	−3.45 (1.95)	−0.43 (0.28)	−1.49 (1.64)	14.045	0.001*	<0.001*	0.349 (NS)	0.018*
Go–Ar	−3.05 (2.03)	−0.48 (0.41)	−1.40 (1.12)	13.09	0.001*	0.002*	0.010*	0.037*
Go–Me	−3.90 (2.95)	−0.50 (0.70)	−1.75 (0.97)	12.746	0.002*	0.002*	0.005*	0.107 (NS)
Ar–Gn	−4.60 (4.56)	−0.20 (0.34)	−1.55 (0.76)	20.388	<0.001*	<0.001*	<0.001*	0.037*
U1–NA (deg)	9.45 (4.69)	−0.54 (0.76)	4.20 (2.29)	19.327	<0.001*	0.001*	<0.001*	0.009*
U1–NA (mm)	2.75 (1.70)	−0.26 (0.33)	2.65 (1.79)	19.674	<0.001*	<0.001*	<0.001*	0.620 (NS)
U1–SN	11.60 (13.14)	0.35 (10.05)	3.85 (3.03)	16.756	<0.001*	<0.001*	0.001*	0.192 (NS)
L1–NB (deg)	−3.45 (3.29)	0.35 (0.67)	−3.60 (2.57)	17.549	<0.001*	<0.001*	<0.001*	0.731 (NS)
L1–NB (mm)	−1.05 (1.18)	0.24 (0.33)	−0.75 (1.05)	10.778	0.005*	0.004*	0.007*	0.360 (NS)
IMPA	−4.00 (3.92)	0.33 (1.12)	−3.30 (2.05)	16.292	<0.001*	0.001*	<0.001*	0.849 (NS)
OVERBITE	1.25 (1.03)	−0.34 (0.47)	0.08 (1.17)	10.425	0.005*	0.001*	0.314 (NS)	0.039*
OVERJET	5.10 (3.07)	−0.19 (1.15)	3.55 (2.59)	19.678	<0.001*	<0.001*	<0.001*	0.148 (NS)
U6 (mm)	−2.50 (6.96)	−0.33 (0.66)	0.95 (5.98)	0.166	0.920 (NS)	0.907 (NS)	0.692 (NS)	0.761 (NS)
L6 (mm)	−7.50 (7.42)	−0.45 (0.59)	−1.90 (6.11)	15.449	<0.001*	<0.001*	0.011*	0.097 (NS)

* Statistically significant

reflecting the concomitant changes in shape and changes in size, respectively.[8]

The sagittal relationship of the anterior limit of the maxillary apical base to the anterior cranial base can be expressed by S–N–A Angle. When the mandible was positioned forwardly by either system, a reciprocal force acted distally on the maxilla impeding its forward growth (headgear effect).[9] Although point A is a deep alveolar point in the maxilla, but it is also influenced by the dentoalveolar changes.[10] But in the present study, the mean decrease in SNA angle was not significant with both the appliances. S–N–B angle, however, increased significantly with both the appliances compared to controls due to the forward shift of point B. There was a statistically and clinically significant improvement in the anteroposterior spatial position of the mandible while using myobrace systems and twin block appliances when compared to the controls. ANB angle showed a highly statistically significant reduction with both the appliances compared to the control group. This change in the treatment group is due to the increase in SNB by the anterior positioning of the mandible along with an insignificant reduction in SNA angle by restraint of forwarding maxillary growth. It must also be noted that more decreases in the ANB angles were seen in the myobrace group than the twin block group probably due to the more increased labial inclination of the lower anterior teeth in the former than the latter.

Facial convexity angle, used as a marker to measure the overall profile changes between subjects increased notably in treatment groups compared to the control group, thus present study showed that there was considerable improvement in the profile of the treatment group especially in the twin block group, as the point Pogonion moved anteriorly due to the favorable forward mandibular growth.

Skeletal rotation of mandible assessed by the cant of the occlusal plane (OP–SN) was significantly reduced in the myobrace group compared to the control group which was due to the forward rotation of the mandible, which is in accordance with findings of Usumez et al.[11] and Oliveria et al.[12] It was observed that in patients who had worn myobrace appliance, there was a forward rotation of the mandible accompanied by an increase in sagittal growth, leading to forward positioning of the mandible. However, in the twin block group, there was an increase in the cant of the occlusal plane which was statistically nonsignificant ($p = 0.533$) and can be attributed to the very negligible supra eruption of mandibular molars which was in accordance with the study conducted by Mills and McCulloch.[10]

Facial growth type assessed by mandibular plane angle (SN–GoGn) increased nonsignificantly in twin block group which was in accordance with Mills and McCulloch,[10] Lund and Sandler[13] suggesting a net increase in anterior and posterior facial height of these patients. However, in the myobrace group, there was a significant decrease which was in accordance with Usumez[11] and Das,[14] probably because of tooth channels and vestibular shields which provided shield effect and bite closure effect allowing anterior rotation of the mandible. Maxillomandibular plane angle (PP–MP) decreased significantly in the myobrace group, thus achieving more success in creating a hypodivergent skeletal pattern when compared to the twin block group.

Facial growth type assessed by Bjork's polygon angles which sum of Saddle angle (N–S–Ar), Articulare angle (S–Ar–Go), and Gonial angle (Ar–Go–Me) decreased significantly in twin block group compared to myobrace and control group. Thus, findings of this study infer twin block would be more successful than myobrace in creating a more forward rotation of the mandible and hence favored the correction of class II malocclusions.

One of the major controversies in functional appliance therapy is the effect of the functional appliance on the increase in size or acceleration of mandibular growth.[15] In the present study, Ramal height (Go–Ar), mandibular body length (Go–Me), and mandibular base length (Ar–Gn) increased significantly in the twin block group compared to the other two groups thus proving the fact that twin block was better in producing skeletal changes favoring the growth of the mandible. These findings were in accordance with Trenouth,[8] Mills and McCulloch,[10] Usumez et al.,[11] Oliveria et al.,[12] Lund and Sandler,[13] Das et al.,[14] Clark,[16] Sidlauskas,[17] and Illing.[18] It must be noted that twin block is the best treatment option when a small mandible is the etiology as they produced a more significant sagittal incremental growth in mandible[16,17] when compared to the myobrace system. An increase in effective mandible length in the treatment group is a combined effect of normal growth increment, the effect of forwarding posturing of the mandible by the appliance (effect of appliance), and downward and backward rotation of mandible (posterior mandibular morphogenetic rotation).

Linear skeletal changes, anterior facial height (N–Me), and posterior facial height (S–Go) increased significantly in treatment groups compared to the control group indicating that there was a significant increase in vertical dimensions of the face in general and mandible in particular with the appliances used. This is in accordance with the findings of the study by Trenouth,[8] Mills and McCulloch,[10] Usumez et al.,[11] Oliveria[12] et al., Das[14] et al., Clark,[16] and Illing.[18] The increase in anterior and posterior facial heights with twin block appliances were more than those achieved with myobrace and were statistically more significant in the posterior facial height suggesting a better correction of mandibular retrognathia with the former than the latter.

Dentoalveolar change in the maxilla was measured using a variable "maxillary incisal angle" which showed the inclination of upper incisors relative to a palatal plane (ANS–PNS). There was a significant reduction in proclination in the intervention group compared to the control group which was both statistically and clinically significant and was in accordance with McNamara,[6] Usumez et al.,[11] Oliveria et al.,[12] Lund and Sandler,[13] Illing et al.,[18] and Toth.[19]

Both twin block and myobrace system resulted in the posterior movement of the upper incisor relative to the OLp and anterior movement of the lower incisor thus reducing the overjet significantly whereas in the control group there was an increase in overjet. Correction of overjet in the intervention groups was a combined effect of maxillary incisor retroclination and mandibular incisors proclination with marked skeletal contribution (forward growth of mandible) at the end of the treatment.[15] This is accordance with Mills and McCulloch,[10] Usumez[11] et al., Das[14] et al., Illing,[18] Toth and McNamara[19] who concluded that lingual tipping of the upper incisors is due to labial wire (twin block) and labial shield (myobrace) that came in contact with the incisors during sleeping hours and use resulting in retraction. Usumez et al.[11] in their study stated that overjet correction with the myobrace system was mainly due to increased lower incisor proclination along with significant skeletal changes.

Mandibular incisor positioning is critical in Class II corrections with myofunctional appliances as their excessive tipping decreases the potential for orthopedic changes. After twin block and myobrace system treatment, there was statistically significant proclination of lower incisor in relation to mandibular plane. However, it must be noted that the control group showed only a nonsignificant increase of 0.35° ($p = 0.136$), which showed that flaring of the lower incisors was an unfavorable outcome of intervention groups. In the twin block group, the lower molar moved more mesially adding to the correction of full cusp Class II molar relationship to Class I molar relation. In the control group, although mandibular growth which could bring the lower teeth forward, was more than maxillary growth on average, seems to be lost by the "block effect" due to intercuspidation, thus resulting in adaptive movements of the dentoalveolar complex. However, it must be noted in the myobrace group that the molar relations however seemed static because of the mesial migration of both upper and lower molars keeping the end on molar relation even after treatment which was in accordance with Uysal.[20] The full cusp Class II molar relation was satisfactorily corrected to a Class I molar relationship with twin block appliances rather than with the myobrace system as witnessed in our study.

According to Anastasi and Putrino,[21] the success of the myobrace system was dependent on the timespan of wear of the appliance which should be not <2 years and should cover the subjects' growth peak. While treating patients with functional appliances, the clinician should always have to deal with patient compliance. The constant stringent patient motivation was imperative during the course of the entire study period for both twin block and myobrace systems as these removable functional appliances are more tissue–borne and therefore with time and patience they are less likely to produce dental adaptive changes thus decreasing the chances of relapse in future. The more favorable success rate with twin block appliances than the myobrace systems can be attributed to the fact that there was a generally high level of patient compliance for twin block appliances because of their smaller size and speech disturbances are minimized. On the other hand, myobrace systems were monobloc systems with considerable speech difficulty encountered during its usage and were less accepted as seen in the study conducted by Idris et al.[22] The patients also reported the "falling off" of myobrace appliance from the mouth especially while sleeping, in contrast to the custom made twin block appliances that were secured to the teeth components using retentive clasps. However, the manufacturers highly recommended wearing the myobrace 1–2 hours before sleep to condition the masticatory muscles and adapt them to the appliance so that they do not fall out from the mouth during sleep. Among the advantages of the myobrace, includes avoiding the need for impressions of the arches, a boon for noncooperative children; no need for complicated appliance insertion often difficult to achieve since children at this age lack patience; comfortable flexible nature of the material which is safe from breakage in contrast to other functional appliances.

De Vincenzo[23] and Pancherz[24] and coworkers reported very disappointing findings with their respective appliances with regard to the long-term stability effects of functional appliance treatment. Our current study on twin block and myobrace systems do not address this issue because of the insufficient long-term follow-up data that was available on such malocclusion corrections. Thus, the present study establishes conclusive evidence of skeletal, dentoalveolar changes leading to Class II Division I malocclusion correction with both twin block appliance and myobrace system, further studies with longer follow-up are required to substantiate the result of the present study.

Conclusion

The following conclusions can be drawn from the present study:

- Twin block and myobrace appliances were not effective in restricting the forward growth of the maxilla and the headgear effect was insignificant or minimal.
- Twin block appliances produced significant skeletal and dentoalveolar changes and provided mandibular growth (Go–Ar, Go–Me, Ar–Gn) in increments greater in magnitude than the myobrace system.
- Myobrace appliances induced more dentoalveolar changes than skeletal changes in the correction of Class II malocclusions in terms of overjet reduction, forward rotation of the mandible, and forward positioning of the mandible than the actual stimulation of the mandibular sagittal skeletal growth increment.
- Twin block appliances demonstrated correction from full cusp Class II molar relationship to Class I molar relationship in a reasonable time frame (8–12 months). On the other hand, the myobrace system achieved no significant correction of molar relation in the same time span.
- Twin block and myobrace showed considerable improvement in the profile of the treatment group patients with the former faring better than the latter.
- Net increase in the anterior and posterior facial heights was more prominent in the twin block group. Bite closure effect (upward cant of occlusal plane and decrease in the mandibular plane angle and maxillomandibular plane angle) was more in the myobrace group.
- Flaring of the lower incisors was an unfavorable treatment outcome that was inevitable in both the intervention groups which was more prominent in the myobrace group than the twin block group.

Limitations of the Study

- Insufficient long-term follow-up data to prove the long-term stability of the myobrace system and twin block appliance.
- Soft tissue profile analysis was not carried out in this cephalometric study and would have been a better marker for the demonstration of soft tissue changes that occurred in the intervention groups.

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