ORIGINAL RESEARCH

Effect of Twin-block Appliance on Pharyngeal Airway, Sleep Patterns, and Lung Volume in Children with Class II Malocclusion

Akriti Batra[1], Vabitha Shetty[2]

ABSTRACT

Aim: In this study, we sought to evaluate the effect of the twin-block appliance on pharyngeal airway dimensions, sleep patterns, and lung volumes in growing children with class II malocclusion with a retrognathic mandible.

Materials and methods: Twenty children aged 9–12 years with class II malocclusion with a retrognathic mandible participated in the study. A validated sleep questionnaire assessed the sleep patterns and the sleep problems of the children. The pre-treatment cephalometric variables and the pharyngeal airway passage (PAP) dimensions were analyzed. Spirometry tests were performed to evaluate lung volumes. A custom-made twin-block appliance was fabricated, and children were instructed to wear it for a minimum of 10 months. All variables including sleep problems, cephalometric variables, and pharyngeal airway measurements were evaluated post-treatment. Spirometry tests were re-evaluated at the end of the twin-block treatment. All data were statistically analyzed.

Results: Post-twin-block appliance treatment, there was a definite decrease in snoring, noisy breathing, and sleeping with mouth open. The sella-nasion to B point angle (SNB), mandibular length, the depths of oropharynx, nasopharynx, and hypopharynx as well as the height of nasopharynx (HNP) were significantly increased post-treatment ($p < 0.001$). The length and thickness of soft palate (SPl) increased significantly ($p < 0.001$), while its inclination decreased significantly ($p < 0.001$). We found improvements in forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV1); however, the changes were statistically not significant ($p = 0.88$ and $p = 0.78$).

Conclusion: Twin-block appliance significantly increased the pharyngeal airway dimensions and improved the length and thickness of the soft palate in children with class II malocclusion. Post-twin-block treatment showed a considerable reduction in the sleep problems of the children. The lung volume measurements showed improvement; however, it was not statistically significant.

Clinical significance: Twin block may be used not only to correct the facial disharmony of children with a retrognathic mandible but also to improve the airway dimensions and lung volume as well as to reduce the sleep-disordered symptoms.

Keywords: Class II malocclusion, Lung volume, Pharyngeal airway, Sleep-disordered breathing, Twin block.

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INTRODUCTION

Sleep-disordered breathing (SDB) is a condition characterized by sustained and increased upper airway resistance or obstruction, partial or complete, that impairs pulmonary ventilation and oxygenation, hence affecting sleep quality.[1] SDB has a prevalence rate of 0–5.7% in general pediatric population. Children with sleep problems exhibit cognitive and social impairment, behavioral, and mood disturbances as well as growth impairment.[2]

The anatomy and function of the nasopharyngeal airways are directly associated with craniofacial development. Owing to their mutual interaction, mandibular deficiency, hypertrophic soft palate, and posteriorly postured tongue were identified as the major anatomical and physiological factors which play a major role in decreased upper airway dimensions.[3–5] Class II malocclusions are the most commonly seen malocclusion in children. Narrowing of upper airway is a common anatomical adaptation in children with mandibular retrognathia. These kinds of compensatory changes in the upper airway may have unfavorable consequences for the lower airway functions, such as lung function. These changes increase the chances of impaired respiratory function during the day, and possibly causing a resultant decrease in airflow during sleep, predisposing the individual to SDB.[6,7]

These changes are seen due to the enhancement of neuromuscular activity. The twin-block appliance is a standard intervention for an early treatment of a child with mandibular retrognathia with studies highlighting improvement in the upper airway passage.[8,9] The twin-block appliance moves the lower jaw forward, preventing the posterior positioning of the tongue and improving the PAP, supplemented with an enhancement of facial esthetics.

The treatment of a posteriorly positioned mandible by myofunctional appliances could also have favorable effects on lung functions. However, there are only few studies stating that mandibular repositioning devices improved the inspiratory and

[1,2]Department of Pediatric and Preventive Dentistry, AB Shetty Memorial Institute of Dental Sciences, NITTE (Deemed to be University), Mangaluru, Karnataka, India

Corresponding Author: Vabitha Shetty, Department of Pediatric and Preventive Dentistry, AB Shetty Memorial Institute of Dental Sciences, NITTE (Deemed to be University), Mangaluru, Karnataka, India, Phone: +91 9448770874, e-mail: docvabitha29@gmail.com

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expiratory total air and decreased nasal resistance in mild and moderate cases of obstructive sleep apnea.[10,11] Any difference in lung function can be determined from pulmonary tests such as spirometry, static lung volumes, and airway resistance. Spirometry test is a simple and commonly used test in patients with respiratory symptoms.[12] The test works by measuring airflow in and out of the lungs. In this study, a validated sleep questionnaire[13] was used to assess the sleep practices and problems of children at the start of the study and at the end of the twin-block appliance therapy. Thus, in this 9-month follow-up clinical study, the effect of twin-block appliance on pharyngeal airway dimensions, sleep patterns, and lung volumes in growing children with class II malocclusion with a retrognathic mandible was evaluated.

MATERIALS AND METHODS

Twenty children requiring twin-block treatment reporting to the Outpatient Department of Pediatric and Preventive Dentistry, AB Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangaluru participated in this prospective study. All growing children in the age range of 9–12 years with skeletal class II malocclusion associated with mandibular retrognathia, who required twin-block therapy, were recruited during the period April–June 2019. A detailed case history, clinical examination, and pre-treatment cephalometric analysis including cervical vertebrae maturity index was done to confirm the skeletal pattern of the children. A total of 35 children were thus initially recruited for the study.

Eligibility Criteria

The children with clinically obvious class II malocclusion in which the esthetic appearance of the child improved when the mandible was postured forward (positive visual treatment objective). On cephalometric evaluation, the children with skeletal class II malocclusion with angle A point to B point angle (ANB) >5° and perpendicular connecting A point to occlusal plane (AO) ahead of perpendicular connecting B point to occlusal plane (BO) (>1 mm) were selected. Further, the children included in the study had a normal maxilla SNA (80–83°) and retrognathic mandible SNB (<78°). The children included in the study also had a predominantly horizontal growth pattern (Jarabak's ratio >65% and *y*-axis <66°). The children with full cusp angle's class II molar relationship bilaterally, minimal or no crowding/spacing in either arch with an overjet >5 mm were included. The children with optimum growth potential (stage 3 cervical vertebrae maturation index) and with good compliance were selected.

Exclusion Criteria

The children with increased vertical growth tendency, children with anterior open bite, posterior crossbites or severe maxillary transverse deficiency were excluded. The children with adeno–tonsillar hypertrophy and mouth breathing habit as well as the children who had undergone pre-functional orthodontic or orthodontic treatment, children with chronic nasal allergies, apparent nasopharyngeal obstructions, septum deviations, upper airway surgeries, and craniofacial anomalies/syndromes were also excluded.

The Research Ethics Committee of the institution approved the study (Certification No. ABSM/EC/54/2018), which was in accordance with the 1964 Helsinki declaration and its later amendments. Informed written consent from the parents and oral assent from the children were obtained.

Assessment of Sleep Practices and Problems

The parents of all participants completed a validated sleep questionnaire[13] regarding their practices and problems at the start of the study and following twin-block therapy. The questionnaire recorded the demographic data of the children and evaluated the sleep practices and specific behavioral patterns of the children. Their academic performance and presence of specific sleep problems were also evaluated.

Cephalometric Analysis

The skeletal, PAP dimension, and posterior pharyngeal wall thickness (PPWT) changes were evaluated from the lateral cephalograms before the start of the treatment. The lateral cephalograms were recorded according to the standard protocols for all children. The PAP was measured using the method by Jena et al.[14] while the PPWT was measured using the method of Joseph et al.[15] A single investigator traced all of the cephalograms manually in one sitting. All variables were measured thrice, and their mean subjected to statistical analysis. The assessment of intraobserver variability and reproducibility of landmark location and measurement errors was analyzed by tracing the 10% randomly selected radiographs after a gap of 15 days.

The Cephalometric Measurements

- Figure 1 represents the specific linear and angular parameters considered to evaluate the skeletal factors and PAP.
- Figure 2 represents the reference planes and linear measurements that were utilized to determine the thickness of the posterior pharyngeal wall.

Twin-block Appliance Design

A custom-made twin-block appliance made of acrylic resin was designed and fabricated for each child. Alginate impression was made. With a vertical opening of 2–3 mm between the upper and the lower incisors and sagittally extending the jaw to an edge-to-edge relation, the appliance's construction bite was recorded. During the wax bite registration, all 20 participants had a one-step mandibular advancement. The children were told to wear the appliance 24 hours a day, specifically during mealtimes, and they were examined every 4 weeks (Fig. 3). After 6 months, the interocclusal acrylic was gradually trimmed in all children to allow for unimpeded vertical development of the mandibular buccal segments. After a 10-month follow-up, the post-treatment cephalograms were used to re-evaluate the skeletal, PAP, and PPWT dimensions. All post-treatment cephalograms were taken according to the protocol mentioned earlier and by the same operator. The children were given a Hawley's appliance with an advanced splint for retention at the end of active treatment for a period of 9 months.

Spirometry Test

Assessment of lung volume using Spirometry (RMS Helio 401) were performed before the start of treatment and at the end of twin-block therapy.

The following tests were carried out:

- FVC in L
- FEV1 in L
- Ratio of FEV1/FVC in %
- Peak expiratory flow$_{25-75}$ in L/s

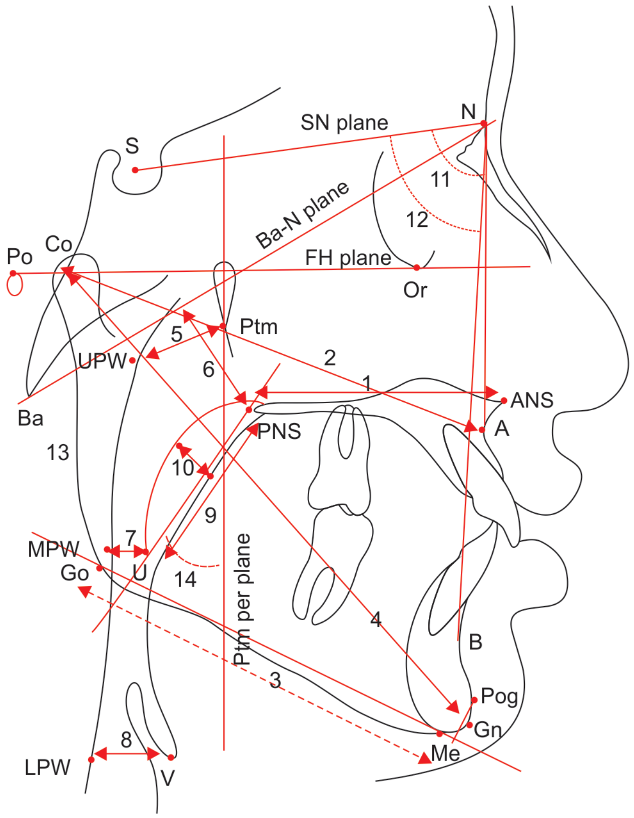

Fig. 1: Cephalometric landmarks, reference planes, linear, and angular parameters 1: Maxillary length (ANS-PNS); 2: Effective maxillary length (Co-A); 3: Mandibular length (Go-Pog ⊥ MP); 4: Effective mandibular length (Co-Gn); 5: DNP (Ptm–UPW); 6: HNP, the shortest linear distance from PNS to Ba-N plane; 7: DOP (U-MPW); 8: DHP (V-LPW); 9: SPL (U-PNS); 10: SPT, the maximum thickness of the soft palate. Angular parameters; 11: SNA, angle between 'S,' 'N,' and 'A'; 12: SNB, angle between 'S,' 'N,' and 'B'; 13: FMA, angle between FH plane and mandibular plane (Go-Me); 14: SPI (Ptm per × PNS-U), the angle between Ptm perpendicular and the soft palate (PNS-U)

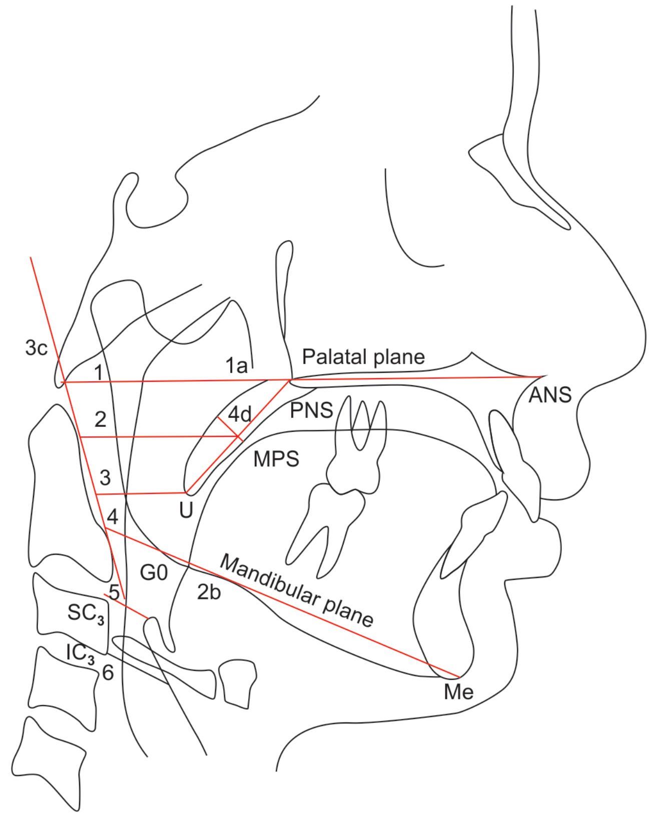

Fig. 2: Reference planes and linear parameters used for evaluation of PPWT change PPWT 1 at nasopharyngeal space 1 (mm); PPWT 2 at nasopharyngeal space 2 (mm); PPWT 3 at oropharyngeal space 1 (mm); PPWT 4 at oropharyngeal space 2 (mm); PPWT 5 at oropharyngeal space 1 (mm); PPWT 6 at hypopharyngeal space 2 (mm)

Figs 3A to C: Clinical intraoral photographs of a patient with the twin-block appliance (A) Frontal; (B) Right lateral; (C) Left lateral views

At the start of the pulmonary function test, the height and weight were recorded and procedure was explained and demonstrated. The nose clip was placed, and a mouthpiece of appropriate size was inserted in the mouth. The individual was instructed to lock their lips securely around the mouthpiece and slowly breathe from and into it. The individual was asked to exhale rapidly and forcefully into the mouthpiece for as long as possible until no more air could be released from the lung. This defined the FVC. This maneuver was performed at least 3 times, with the best possible value being taken into consideration and compared to the expected normal values.

Data Analysis

The data collected were entered into Microsoft excel spreadsheet and analyzed using IBMSPSS Statistics, Version 22 (Armonk, NY: IBM Corp). The descriptive data were presented in the form of frequency; percentage for categorical variables; and in the form of mean, median, standard deviation, and quartiles for continuous variables. The McNemar test was used to compare categorical data before and after therapy. As the data was not following normal distribution, non-parametric test was used. The Wilcoxon Sign rank test was used to compare pre- and post-treatment cephalometric pharyngeal airway dimensions, PPWT, and spirometry results. The value $p < 0.05$ was considered statistically significant.

RESULTS

A total of 35 children were recruited for the study. However, 20 children completed the twin-block treatment with their 10 months regular follow-up and were thus retained in the study for analysis. The mean age of the children was 11.20 ± 1.44 at the start of the study, with 11 boys and 9 girls. The mean total treatment duration and follow-up was 274 ± 1.55 days.

Skeletal Changes

The pre-treatment and post-treatment skeletal changes are described in Table 1. The change in effective maxillary length was –1.33 mm, which was statistically significant ($p < 0.001$). The change in sagittal position of the mandible (SNB angle) was 2.42, which was statistically significant ($p < 0.001$). The change in mandibular length was +2.17 mm, which was statistically significant ($p < 0.001$).

Pharyngeal Airway Passage Changes

The pre-treatment and post-treatment PAP changes are described in Table 2. There was a significant increase in the depths of hypopharynx (DHP), nasopharynx (DNP), and oropharynx (DOP) as well as the HNP, i.e., +3.76 mm, +0.87 mm, +2.1 mm, and +1.02 mm, respectively, post-treatment ($p < 0.001$). Both soft palate length (SPL) and soft palate thickness (SPT) were raised by 1.57 mm and 0.55 mm, respectively, after twin-block therapy ($p < 0.001$). The inclination of soft palate significantly decreased from a mean pre-treatment value of 36.95° to a mean post-treatment value of 35° ($p < 0.001$).

Posterior Pharyngeal Wall Thickness

The pre- and post-treatment group comparisons of thickness of posterior pharyngeal wall are described in Table 3. The mean post-treatment PPWT at nasopharynx, oropharynx, and hypopharynx was found to be decreased; however, it was statistically not significant (PPWT 1: –0.24, PPWT 2: –0.11, PPWT 3: –0.26, PPWT 4: –0.07, and PPWT 5: –0.16, PPWT 6: –0.19, respectively) ($p > 0.05$).

Sleep Problems and Practices

Analysis of sleep practices at the start of the study revealed that up to half of the children (50%) had a regular bedtime; 18 children (90%) shared a bedroom while up to 17 children (85%) shared a bed–either with parents or siblings. This means that almost all children who shared a bedroom also shared a bed (co-sleeping). Six children (30%) liked to keep the light on at night; however, 14 of them (70%) preferred the light to be switched off. The parents of six children (30%) affirmed that they found difficulty in getting their children to go to bed. Meanwhile, the parents of 17 children (85%) reported difficulty in waking them up in the morning during weekdays. There was not much change in the sleep practices post-treatment. Analysis of sleep problems showed that up to 15 children (75%) displayed at least one sleep problem, out of which snoring was reported in 12 children (80%), noisy breathing in seven children (46%), frequent awakening in three children (20%). All children with sleep problems (15 children) were observed to sleep with their mouth open. Post-treatment assessment of the sleep problems showed that snoring was reported in only three children, noisy breathing in two children and only seven children reported sleeping with mouth opening.

Table 1: Skeletal changes pre-treatment and post-treatment

					Wilcoxon sign rank test	
	N	*Mean (SD)*	*Range*	*Median (Q1–Q3)*	*Z*	*p*[*]
SNA						
Pre	20	81.48 (3.14)	73–84.5	82.5 (81.5–83)	–1.06	0.29 (NS)
Post	20	81.25 (3.19)	73–85	82 (80.5–83)		
Maxillary length (mm) (ANS–PNS)						
Pre	20	47.55 (2.55)	41.5–50	48.25 (47–49.75)	–1.20	0.23 (NS)
Post	20	47.70 (2.45)	42–51.5	47.75 (47.5–49)		
Effective maxillary length (mm) (Co-A)						
Pre	20	78.30 (1.62)	75–80.5	78.5 (77–79.5)	–3.75	<0.001
Post	20	79.63 (2.06)	76–82	80.5 (77.5–81)		
SNB						
Pre	20	74.18 (1.00)	73–76	74 (73.5–75)	–3.97	<0.001
Post	20	76.60 (1.12)	75.5–79	76 (75.63–78)		
Mandibular length (Go-Pog ⊥ MP)						
Pre	20	61.08 (2.04)	57–64.5	60.5 (60–62.75)	–3.96	<0.001
Post	20	63.25 (2.34)	58–67	63 (62–65)		
Effective mandibular length (mm) (Co-Gn)						
Pre	20	93.95 (4.54)	86–98	96.25 (91–97)	–3.96	<0.001
Post	20	97.90 (4.71)	89–105	99 (95 101.75)		

[*] Not significant when $p > 0.05$; statistically significant when $p < 0.05$

Table 2: Pharyngeal airway passage changes pre-treatment and post-treatment

					Wilcoxon sign rank test	
	N	*Mean (SD)*	*Range*	*Median (Q1–Q3)*	*Z*	p^*
DHP (mm) (V-LPW)						
Pre	20	11.38 (3.09)	7–17	11 (9.13–14)	–3.94	<0.001
Post	20	15.15 (2.22)	12–19	16 (13–16.88)		
DNP (mm) (Ptm-UPW)						
Pre	20	14.08 (2.67)	10–17	15 (11–16)	–3.99	<0.001
Post	20	14.95 (2.86)	10.5–18.5	15.75 (11.5–16.5)		
DOP (mm) (U-MPW)						
Pre	20	8.58 (2.15)	6–12.5	8 (8–9)	–3.97	<0.001
Post	20	10.68 (3.04)	7.5–16.5	9.75 (9.5–10)		
HNP (mm) (PNS to Ba-N plane)						
Pre	20	18.18 (2.70)	14–22	18.5 (17–21)	–4.03	<0.001
Post	20	19.20 (2.89)	14.5–23	20 (17.5–22)		
SLP (mm) (U-PNS)						
Pre	20	28.63 (3.40)	25–34	27.25 (26–32)	–3.94	<0.001
Post	20	30.20 (3.37)	26–35	30 (27–32.5)		
SPI (Ptm per × PNS-U)						
Pre	20	36.95 (6.47)	27–46	37.5 (34–40)	–3.95	<0.001
Post	20	35.00 (6.62)	24–45	35.25 (32.25–38)		
SPT (mm) (Maximum thickness of soft palate)						
Pre	20	12.40 (1.88)	8–16	12 (12–14)	–3.84	<0.001
Post	20	12.95 (1.83)	8.5–15.5	12.75 (12.5–14.5)		

*Not significant when $p > 0.05$; statistically significant when $p < 0.05$

Spirometry Changes

In this study, there was an increase in the mean values of all parameters FVC(L), FEV1(L), and FEV1/FVC% from pre-treatment to post-treatment, but these changes were not statistically significant ($p > 0.05$, Table 4).

The results of this study showed that twin-block appliance has significantly increased the SNB angle and length of mandible while length of the maxilla decreased. The results revealed significant increases in depth and height of pharyngeal airway space post-twin-block therapy along with a significant improvement in length and thickness of soft palate, while inclination (angulation) reduced. However, no significant change was observed in thickness of posterior pharyngeal wall following twin-block therapy. There was a considerable reduction in snoring and other sleep problems in the children post-twin-block therapy. The lung volume measurements using spirometry showed improvement; however, they were not statistically significant.

DISCUSSION

During childhood, SDB is frequently linked to four main risk factors: adeno–tonsillar hypertrophy; allergies and asthma; and obesity and craniofacial abnormalities.[5,16] Airway narrowing as a result of anatomical or physiological restrictions during craniofacial development such as mandibular deficiency can predispose an individual to SDB. With age, a decrease in oropharyngeal depth and an increase in the length and thickness of the soft palate, as well as subsequent soft tissue alterations, have a role in limiting the oropharyngeal airway in these children.[17]

According to Clark, the occlusal inclined planes of the twin-block appliance were the fundamental functional mechanism of the natural dentition and their inclination played an important role in determining the relationship of teeth.[18] Occlusal forces transmitted through the dentition provide a constant proprioceptive stimulus to influence the rate of growth and trabecular structure of growth. Utilization of these mandibular advancement devices at an early age can protect a child from long-term respiratory disturbances as they expand the upper airway and improve respiratory function by bringing the mandible forward.[19]

In this study, there was a notable raise in the SNB angle following twin-block appliance, indicating a favorable forward growth of the mandible. This finding implies that the anterior mandibular repositioning was primarily used to rectify the sagittal disparity of the jaws. This was corroborated by an increase in mandibular length (including the effective mandibular length). A reciprocal force acted distally on the maxilla when the mandible was positioned forward by the twin-block device, inhibiting its forward growth and encouraging forward mandibular growth hence there was

Table 3: Comparison of pre- and post-treatment posterior PPWT

					Wilcoxon sign rank test	
	N	*Mean (SD)*	*Range*	*Median (Q1–Q3)*	*Z*	*p**
PPWT1						
Pre	20	17.30 (1.67)	15.00–20.00	17.00 (16.00–19.00)	–0.41	0.69 (NS)
Post	20	17.06 (1.63)	14.80–19.80	16.60 (15.80–18.70)		
PPWT2						
Pre	20	14.35 (2.31)	11.50–18.00	13.75 (12.25–17.00)	–1.44	0.15 (NS)
Post	20	14.24 (2.25)	11.30–17.80	13.67 (12.10–16.80)		
PPWT3						
Pre	20	11.60 (3.55)	4.50–15.50	12.25 (10.00–15.00)	–1.25	0.21 (NS)
Post	20	11.34 (3.15)	4.30–15.40	12.1 (10.20–15.00)		
PPWT4						
Pre	20	8.05 (3.18)	4.00–13.50	8.25 (4.63–11.00)	–1.34	0.18 (NS)
Post	20	7.98 (3.10)	4.00–12.80	8.12 (4.40–10.80)		
PPWT5						
Pre	20	6.32 (2.34)	3.50–10.50	5.75 (4.10–8.00)	–0.68	0.50 (NS)
Post	20	6.16 (2.23)	3.30–10.00	5.90 (4.14–7.80)		
PPWT6						
Pre	20	4.31 (1.23)	2.90–7.00	4.00 (3.50–5.00)	–0.21	0.83 (NS)
Post	20	4.12 (1.15)	2.80–6.80	3.80 (3.32–4.9)		

*Not significant when $p > 0.05$; statistically significant when $p < 0.05$

Table 4: Changes in lung volume pre-treatment and post-treatment

					Wilcoxon sign rank test	
	N	*Mean (SD)*	*Range*	*Median (Q1–Q3)*	*Z*	*p**
FVC (L)						
Pre	20	2.36 (0.49)	1.31–3.10	2.32 (1.99–2.78)	–0.891	0.88 (NS)
Post	20	2.42 (0.49)	1.40–3.16	2.35 (2.01–2.80)		
FEV1 (L)						
Pre	20	1.90 (0.07)	1.83–1.99	1.90 (1.83–1.98)	–0.832	0.78 (NS)
Post	20	1.99 (0.10)	1.85–2.14	1.99 (1.88–2.10)		
FEV1/FVC%						
Pre	20	88.00 (5.78)	77.00–95.09	89.0 (84.93–93.14)	0.000	1.00 (NS)
Post	20	87.10 (4.64)	79.10–93.28	88.10 (86.1–91.99)		
FEF25-75 (L/s)						
Pre	20	2.24 (0.03)	2.18–2.29	2.24 (2.22–2.28)	–0.901	0.90 (NS)
Post	20	2.28 (0.03)	2.20–2.33	2.29 (2.27–2.31)		

*$p > 0.05$ not significant; $p < 0.05$ statistically significant

a decrease in the SNA angle which was however not statistically significant. Many prior investigations have found comparable results after twin-block therapy.[17,20,21] However, in this study, the effective maxillary length condylion to point A (Co-A) showed an increase suggesting that the restriction of maxillary growth was limited to the maxillary alveolar process. When post-treatment pharyngeal airway measurements were analyzed, there was a significant improvement in the depths of nasopharynx, oropharynx, and hypopharynx as well as in the HNP. The oropharyngeal airway dimensions are altered by the expansion of the oropharyngeal capsule as a result of the stretch and stimulation of oropharyngeal muscles caused by mandibular advancement. A slow maxillary expansion screw was incorporated in upper component of the twin block. The expansion of the maxillary arch, along with forward growth of mandible leads to a forward relocation of tongue, thereby leading to a significant increase in the pharyngeal space. The increase in the oropharyngeal airway space is in concordance with multiple other studies;[19,20] however, only few studies reported an increase in both superior and inferior dimensions following twin-block therapy.[22,23]

In this study, significant improvement in the soft palate-related measurements were observed. There were significant increases in SPL and thickness of the soft palate SPT, while inclination of the SPI decreased significantly. These changes were probably due to the anterior displacement of the mandible which caused more anterior traction of the tongue away from the soft palate and which changed the soft palate dimensions and inclinations. Similar results were found by Jena et al. who found marked improvement in SPL and thickness in children following functional appliance treatment.[14] These findings were also supported by a systematic review by Mohamed et al. who evaluated airway changes following twin-block appliance and found that twin-block appliance causes mandibular advancement and forward positioning of the tongue, which in turn relieves the pressure on the soft palate, thus leading to an increase in upper oropharyngeal dimension and improved airway permeability.[23]

Few studies have investigated the PPWT in OSA subjects and the effects of oral appliances on PPWT.[24,25] In our study, The PPWT at the nasopharynx, oropharynx, and hypopharynx levels were lowered; however, these changes were not significant. A similar finding was reported by Ghodke et al. who found that the use of a twin-block appliance to correct mandibular retrognathism in class II malocclusion subjects had no effect on PPWT.[9]

In this study, to examine a three-dimensional airway space, two-dimensional lateral cephalograms were used, which did not possess the ability to identify possible alterations in transverse dimensions. The repeatability of pharyngeal dimensions on two-dimensional cephalograms, on the other hand, is quite exact, and it also avoids the necessity for the three-dimensional imaging techniques' additional unnecessary radiation exposure.[26] Radiographic computed tomography (CT) provides a more accurate estimate of upper airway volume and more details compared to conventional radiography.[27,28] However, exposing a growing child to higher radiation is contrary to the as low as reasonably achievable (ALARA) principle and is difficult to justify from an ethical perspective.

A sleep questionnaire, which was validated for a previous study to determine the prevalence of children's sleep practices and problems, was used to assess sleep practices and problems.[13] At the start of the study, it was noted that only half of the children (50%) observed a regular bedtime. Interestingly, almost all children (90%) shared a bedroom, while up to (85%) of them shared a bed as well– with either a parent or sibling. This could reflect the cultural, social, and familial norms in India which emphasize the development of interdependence and family closeness and is accepted by many families. Bed sharing is prevalent in other Asian countries as well.[29,30] Sleep practices of the children were assessed to identify those factors in the child's home environment, which were not conducive to good sleep habits and practices. However, no appreciable change in these practices post-twin-block treatment were observed in spite of child/parent counselling. This could be attributed to the fact that a change in such habits needs considerable time to come into effect.

In this study, a decrease in sleep problems related to SDB symptoms corroborating with the improvement in the dimensions of the airway was observed. However, no notable difference could be identified in certain sleep problems such as frequent awakening, restless sleep, bed-wetting, night terrors and sleep talking. Hence, for these sleep problems, a pediatrician referral is recommended. As many variables determine sleep patterns and problems, we could not conclusively attribute the effects of twin-block treatment toward the same.

Patients with obstructive sleep apnea have various structural and functional abnormalities of the airway during sleep which may reflect on their pulmonary functions. Pulmonary function assays such as spirometry, static lung volumes, and airway resistance can be used to assess changes in various lung functions. In this study, lung volume was assessed using spirometry since it is a painless and convenient test especially for children. Spirometry tests (FVC, FEV1, FEV1/FVC%, and FEF25–75%) showed an improvement post-twin-block appliance; however, these changes were not significant statistically. Forced vital capacity (FVC) is the greatest total amount of air one can forcefully breathe out after breathing in as deeply as possible. An increase in FVC is interpreted as decreased resistance to breathing. In our study, we found an increase in FVC; however, it was not significant statistically. Forced expiratory volume is the amount of air once can force out of lungs in 1 second. This helps in highlighting the severity of breathing problem, if any. There was an improvement in FEV1 at the end of the treatment; however, it was not significant statistically. The ratio FEV1/FVC is a number that represents the percentage of the lung capacity that one is able to exhale in 1 second. The higher the percentage derived from the ratio, the healthier the lungs are. In this study, there was a decrease in this ratio, which was however statistically not significant. Therefore, it could be inferred that twin-block appliance seemed to have a beneficial effect on lung volume in this study. The effects of twin-block appliance therapy on lung functions in class II malocclusion participants with retrognathic mandibles were investigated by Pupneja et al. They discovered that using a twin-block appliance to treat mandibular retrognathism had only minor effects on pulmonary function.[12] The upper airway region, which makes up a very minor part of the total respiratory tract, is likely influenced by the twin-block appliance. Spirometry tests, on the other hand, determine the function of the entire respiratory tract. This could be a probable reason a statistically significant change in lung volumes was not observed.

Thus, this study showed that the twin-block appliance appears to effectively protrude the mandible as well as improve airway dimensions. Long-term follow-up studies are needed to better understand the effectiveness and stability of the twin-block appliances in enhancing airway functioning.

CONCLUSION

Correction of mandibular retrusion in children with class II malocclusion by twin-block appliance had a marked effect in increasing the pharyngeal airway dimensions and also improved the length and thickness of soft palate. There was a definite reduction in the sleep problems of the children post-twin-block appliance. Lung volume measurements using spirometry showed an improvement following twin-block appliance; however, it was not significant statistically. Twin block may be used as a treatment modality not only to correct facial disharmony of children with a retrognathic mandible but also to improve airway dimensions and to reduce sleep-disordered symptoms, thus reducing the risk of development of SDB in adulthood.

Recommendations

- Detailed evaluation of airway should be planned during myofunctional therapy of growing children.
- The importance of identifying risk factors and predictors for SDB at an early stage is of importance in these children so that early intervention could be instituted.
- Functional appliance therapy in growing children with an anatomic predisposition to narrowing of the pharyngeal airways should be considered as an integral part of their clinical management strategy.

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