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A Cephalometric Study of Pharyngeal Dimensions Following Twin Block Treatment

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Author`s Contribution

[1,2]Substantial contributions to the conception or design of the work; or the acquisition, Concept and design of the work, acquisition, [3]Final approval of the study to be published, Data Analysis, [4]Active participation in active methodology, Literature review

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ABSTRACT

Objective: To assess and compare changes in pharyngeal airway widths (PAW) using lateral cephalograms before and after treatment with a removable twin block appliance.

Methodology: Lateral cephalogram records were taken before (T0) and after (T1) the treatment of 50 Class II subjects (ANB>40; 28 males, 22 females; mean age 12.6 years) using the removable twin block appliance. The study period spanned 12 months. Airway volumes, including upper airway width (UAW), middle airway width (MAW), and lower airway width (LAW), were compared between T0 and T1. The data were analyzed using SPSS statistical software via paired t-test. A p-value of ≤0.05 was considered statistically significant.

Results: A total of 50 patients were included in the study, and airway changes were analyzed at two different times prospectively (T0 and T1). The male-to-female ratio was 1:0.8 (44% females, 56% males). The mean upper airway width (UAW) at T0 and T1 was 14.04 mm and 15.3 mm, respectively. The mean middle airway width (MAW) at T0 and T1 was 8.8 mm and 11.8 mm, respectively, while the mean lower airway width (LAW) at T0 and T1 was 7.5 mm and 10.2 mm, respectively. The mean age was 12.6 years, and the mean BMI was 21. The mean SN-Md angle was 31.8 degrees. At T1, a significant increase in airway volume was observed in upper airway width (UAW), middle airway width (MAW), and lower airway width (LAW) (P=0.000).

Conclusion: Treatment with the Twin Block Appliance in growing subjects resulted in an increase in the overall posterior pharyngeal airway volumes.

Keywords: Removable twin block, retrognathic mandible, airway volume, PAW.

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Introduction

Dental and skeletal malocclusion patterns vary a lot from population to population. The most common pattern of malocclusion among South Asian population is skeletal class II.[1] The anatomy and function of nasopharyngeal airway has got direct association with craniofacial development. Nasal stenosis or adenoidal hypertrophy which is associated with mouth breathing and an altered cranio-cervical posture, results in adenoid facies /long face syndrome.[2] Factors like shortened/retro posed mandible, increased size of tongue and soft palate, obesity, posterior postured tongue and vertical growth discrepancy may play a role in airway narrowing.[3] OSA is a clinical disorder characterized by recurring episodes of upper airway obstruction leading to reduced or absent airflow through the nasal or oral cavity. Retro posed mandible has been considered an important risk factor in children and adolescents suffering from sleep disordered breathing or obstructive sleep apnea.[4] The ideal treatment for a growing child diagnosed with a class II skeletal pattern due to mandibular retrognathism, is a functional orthopedic appliances.[5] similar appliances are used for patients with obstructive sleep apnea too.[6-7] Hence this study was designed to assess changes in pharyngeal airway following twin block (TB) treatment.

Methodology

A total of 50 patients diagnosed with mandibular retrognathia and seeking treatment at the Department of Orthodontics and Dento-facial Orthopedics, KRL Hospital in Islamabad were included in this study using consecutive non-probability sampling. The study spanned a 12-month period from November 2018 to November 2019. The sample size calculation was based on a 95% confidence interval and a sample power of 80%, with reference to a study conducted by Jena et al8. Patients with breathing difficulties, dentofacial syndromes, a history of trauma, mouth breathing, prior orthodontic treatment, and obesity were excluded from the study.

Inclusion criteria for participants were as follows: age between 11 and 14 years, skeletal cervical vertebral stage 3, a normal SN-MP angle (32º±4), Angle's Class II division 1 malocclusion, and the availability of high-quality radiographs at both the beginning (T0) and the end (T1) of twin block treatment.

Initial lateral cephalometric radiographs of the study subjects were obtained before the initiation of treatment (T0), while end-treatment radiographs were taken after the removal of the twin block (TB) appliance (T1). During the cephalogram capture, all subjects maintained maximum intercuspation of their teeth and stood in an upright position with the Frankfort horizontal (FH) plane parallel to the floor. All radiographs were exposed using the same cephalostat and with a standard film-to-tube distance.

Subsequently, the cephalograms were manually traced on acetate sheets mounted on an illuminator using a 0.5 mm lead pencil. Landmarks were identified as detailed in Table 1. Linear and angular measurements, which included the evaluation of the pharyngeal airway, the relationship of the mandible with the cranial base, and definitions of the cephalometric planes, are presented in Table II and Figure 1. Linear and angular readings were recorded using a millimetric ruler and a protractor, respectively. Corrected values of linear measurements were recorded to correct for a magnification error of 10%.

To assess intra-observer reliability, measurements for 15 randomly selected lateral cephalograms were repeated by the same investigator four weeks after the initial analysis. Gender was documented in terms of frequency and percentage, while quantitative variables such as age, SN-MP, and BMI were expressed as means. Upper, middle, and lower airway widths were reported as the mean change with the associated standard deviation at baseline (T0) and at the end of the study (T1).

Table I: Anatomical Landmarks Used for Skeletal and Pharyngeal Analysis.

Landmarks	Definitions
Point B (B)	The deepest point between infra dentale and pogonion.
Pogonion (Po)	Most anterior point on bony chin
Sella (S)	The anatomical center of sella turcica.
Nasion (N)	The midline point at the fronto-nasal suture.
MSP	Mid-point of soft palate which is the intersection of the PNS-U line.
PNS	Posterior nasal spine.
U	Tip of soft palate.
MP’	Point of intersection of posterior border of tongue and lower border of mandible.
PPW	Posterior pharyngeal wall
MP	Line between Go and Me
Go	Angular point at the intersection of ramus and inferior border of the mandible
Me	Most inferior point on bony chin

Table II: **Skeletal And Pharyngeal Measurement.**

Planes/Angles	Definitions
SNB angle	The angle between Sella-Nasion line and point B (Normal=80±2°)
LAW	Lower airway width; the distance from MP to PPW
MAW	Middle airway width; distance from U to PPW
UAW	Upper airway width; distance from PNS to PPW
SN-MP angle	The angle between the MP and Sella (S) to nasion (N) line
.Mandibular plane	Line between Go and Me

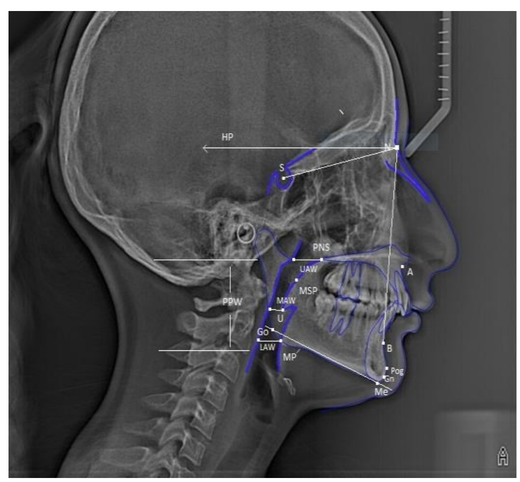

Figure 1. Anatomical landmarks used for Skeletal and pharyngeal analysis.

The data was subjected to statistical analysis using SPSS software, employing paired t-tests to determine statistical significance, with a threshold set at a p-value of ≤0.05.

A total of 50 patients were included in the study and analyzed for airway change at two different times prospectively (T0 and T1).

The male to female ratio was 1:0.8 (44% females/56 %males). Mean upper airway width (UAW) at T0 and T1 was 14.04 mm and 15.3mm respectively, mean middle airway width (MAW) at T0 and T1 was 8.8mm and 11.8mm respectively, while mean lower airway width (LAW) at T0 and T1 was 7.5mm and 10.2mm respectively. Mean age was 12.6 years. Mean BMI was 21. Mean SN-Md angle was 31.8 degrees.

Results

A total of 50 patients were included in the study and analyzed for airway change at two different times prospectively (T_0 and T_1).

The male to female ratio was 1:0.8 (44% females/56 %males). Mean upper airway width (UAW) at T_0 and T_1 was 14.04 mm and 15.3mm respectively, mean middle airway width (MAW) at T_0 and T_1 was 8.8mm and 11.8mm respectively, while mean lower airway width (LAW) at T_0 and T_1 was 7.5mm and 10.2mm respectively. Mean age was 12.6 years. Mean BMI was 21. Mean SN-Md angle was 31.8 degrees. (Table III)

Table III: Descriptive Statistics.

	Min	Max	Mean	SD
UAW T1	12.00	19.00	15.29	1.61
UAW T0	10.00	18.00	14.04	1.82
MAW T1	8.50	15.00	11.38	1.51
MAW T0	6.00	12.00	8.85	1.52
LAWT1	3.00	13.00	10.20	1.86
LAW T0	4.00	10.00	7.55	1.55
BMI	17.00	24.00	21.23	1.87
SN-MP	28.00	36.00	31.79	2.49
Age	11.00	14.00	12.59	1.01

Table IV: Changes In Airway Size After Twin Block Therapy

Variables (T1-T0)	Mean	SD	P value
Upper Airway change	1.250	0.790	0.000 *
Middle airway change	2.530	0.991	0.000 *
Lower airway change	2.670	1.783	0.000 *

* $p \leq 0.05$, Paired *t*-test

Table V: Changes In Airway Size after Twin Block Therapy in Males and Females

Variables	Gender groups	Mean	SD	P. value
Upper airway change	Male	1.267	0.799	0.739
	Female	1.181	0.748	
Middle Airway Change	Male	2.464	1.062	0.520
	Female	2.568	0.916	
Lower Airway Change	Male	2.982	0.917	0.140
	Female	2.727	1.151	

After 09 months of treatment with twin block appliance change in posterior airway widths i.e., the mean change in upper, middle and lower pharyngeal airways in all subjects were 1.25mm, 2.53mm and 2.67 mm respectively. This increase in posterior pharyngeal airways was statistically significant (p=0.000). (Table IV) Overall change between males and females was insignificant. (Table V)

Discussion

A narrow pharyngeal airway established earlier in life can predispose individuals to sleep-disordered breathing, and further reductions in airway dimensions can occur due to subsequent soft tissue changes related to factors such as age, obesity, or genetic background.[8] While a lateral cephalogram is not the ideal tool for assessing airways, its use is well-established due to its highly accurate reproducibility in measuring airway dimensions.[9-10] 3D imaging is not widely available at all centers and involves a high radiation dose, making the lateral cephalogram a valuable and reliable diagnostic tool.[11]

In a study by Hanggi et al., the change in posterior pharyngeal dimensions was found to be insignificant for class II controls.[12-13] However, our study observed a clear improvement in skeletal class II patterns with Twin Block therapy, aligning with findings from multiple other studies.[13-16] The increase in upper airway space in our study is similar to changes reported in several other studies.[13, 14, 16] Specifically, we found a 1.25mm increase in upper airway width, which is comparable to the 2mm increase reported by Han et al. in their study on patients who had undergone Bionator treatment.[13] Similar to our findings, Goymen et al. reported an increase in upper, middle, and lower airway dimensions. [15] However, a few other studies found an increase only in the superior and inferior pharyngeal dimensions.[19-20]

More recently, Jena et al. also reported an increase in pharyngeal dimensions following Twin Block therapy among subjects with a retrognathic mandible.[14] Gul et al. noted that after class II correction, anterior displacement of the mandible and hyoid bone caused an anterior traction of the tongue, resulting in a 1.9mm increase in middle pharyngeal airway space and a reduction in airway resistance.[16] Early treatment with mandibular advancement devices, functional appliances (fixed or removable), or surgical interventions can protect children from long-term respiratory disturbances.[14-17] The benefits of oral appliance therapy on upper airway dimensions in obstructive sleep apnea patients are well-established.[4-6]

When evaluating airway dimensions for gender dimorphism, our findings were consistent with a study by Abu Allhaija and Al-Khateeb, as we found no significant gender-based differences in airway dimensions.[18]

Our study, being prospective in nature, had the strength of accounting for a significant confounding factor, namely BMI, by excluding subjects with a BMI greater than 25. The findings of this study indicate that the Twin Block appliance had a positive impact on the airway, with the potential to alter the posterior airway width by increasing the distance between the soft palate and the posterior pharyngeal wall. This was primarily achieved by changing tongue posture and redirecting the mandible forward, thereby relieving airway constriction. In addition to this, the proposed concept of mandibular catch-up growth may further aid in resolving respiratory distress.

Conclusion

Twin block appliance treatment, in growing subjects, increased the overall posterior pharyngeal airways volumes, specifically the middle and lower pharyngeal airways.

Limitations: To establish the use of functional appliances as an interceptive treatment modality in growing children with narrow pharyngeal airways, long term observations using a control group are required.

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