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Case Study

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‘EVALUATION OF EFFECTS OF THE TWIN BLOCK APPLIANCE (TBA) THERAPY ON CHANGES IN POSTERIOR PHARYNGEAL AIRWAY SPACE DIMENSIONS AND IMPROVEMENT IN MILD SLEEP APNOEA SYMPTOMS IN CLASS 2 DIV 1 GROWING PATIENT WITH RETROGNATHIC MANDIBLE: A CASE REPORT

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ABSTRACT

Objective: To evaluate the effect of twin block appliance for changes in posterior pharyngeal airway (PPA) dimensions and improvement in mild sleep apnoea symptoms in class 2 division 1 growing patient with retrognathic mandible in a case report. **Materials and Methods:** 13 years old male patient with retrognathic mandible class 2 molar relation large overjet and the deep overbite selected for the case report. Polysomnography was done to confirm the sleep apnoea symptoms. Pt. given a twin block appliance with instructions to wear 24 hrs a day until the patient got pterygoid reflex. Preoperative and postoperative conventional Lateral ceph taken, traced manually on an 8×16 matte tracing sheet with an HB pencil. Various landmarks were used for cephalometric evaluation. **Results:** Marked improvement in the SA symptoms posts sagittal correction in the patient TBA therapy. There was a decrease in soft palatal length post-treatment and an increase in soft palatal thickness. Significant improvement seen in soft palate inclination following class 2 correction. Depth of the Oropharynx and Hypopharynx increased significantly post-treatment. **Conclusion:** Significant improvement of sleep apnoea symptoms in this patient, which showed that class 2 correction by a twin block appliance may help in reducing predisposing factors of obstructive sleep apnoea by mandibular advancement.

KEYWORDS: Twin Block Appliance, Sleep Apnoea, Polysomnography, Retrognathic Mandible, Pterygoid reflex. **Aberrations used**: PPA–Posterior pharyngeal airway, TBA–Twin block appliance, SA-sleep apnoea, DOP-the depth of oropharynx, PAP-Pharyngeal airway passage.

INTRODUCTION

What is sleep apnoea? Sleep apnoea (SA) in adults is nothing but the cessation of airflow for 10 seconds or more during sleep with oxygen desaturation of more than 3 seconds and/or associated with arousal. These apnoeic-hypopnoeic spells last for 10-30 seconds in adults. SA refers to the occurrence of 5 or more apnoea- hypopnoea episodes (AHI > 5 hr), resulting in sleep disturbance and low oxygen saturation.[1] AHI is a tool for diagnosing SA and, defined as the average number of apneas and hypopneas per hour of total sleep time.[2]

For Pediatric cases guidelines for diagnosis are available.[3] AHI of 1 or higher is diagnostic for SA in children. Pediatric SA severity was classified as mild (AHI 1 to < 5); moderate (AHI 5 to 10); and severe (AHI >10). Furthermore, Arterial oxygen saturation measured by Pulse oximetry was also used for the diagnosis of hypoxemia. Subsequently, Hypoxemia severity was classified as mild (85%–91%), moderate (75%–84%), and severe (<75%).[3]

The incidence of sleep apnoea in school going children is approximately 2-10%.[4] A small Pharyngeal airway dimension is a characteristic feature in such patients.[5] Sleep Apnoe First reported in children by Guilleminault et al. in 1976.[6] However, in upper airway sleep disorder, children do not necessarily experience apnoeic or hypopnoeic spells but have loud snoring. Also, snoring is a characteristic of SA in children.[7]

Pathophysiology (Fig.1[8])

The retrognathic mandible is considered as one of the risk factors for sleep apnoea.[9] When the position of the mandible is more retrognathic to the cranial base (Low SNB angle), this results in a shortening of the space between the cervical column and the body of the mandible. Therefore, This leads to the alteration in the tongue and soft palate position. Thus, the tongue and the soft palate placed more posteriorly and increase the chances for impaired and restricted respiratory functions such as snoring, upper airway resistance, and sleep apnoea syndrome.[10,11,12] Additionally, other frequent causes of obstruction especially in children include adenoids and enlarged tonsils. Moreover, posterior and inferior placement of hyoid bone can also be considered a good contributory factor.[13]

Craniofacial/skeletal features

In sleep apnoea, there is a reduction in the activity of the Tensor veli palatini and the Genioglossus muscles that result in decreased airway space.[14] Patients with long face syndrome and patients with mandibular deficiency or retrusion are more susceptible.[15] Likewise, retro positioned mandible, narrow posterior airway space, enlarged tongue, and soft palate, the inferior position of the hyoid bone, and retroposition maxilla are also risk factors for sleep apnoea. Furthermore, in maxillary deficiency, retropalatal space is decreased.[16,17,18,19]

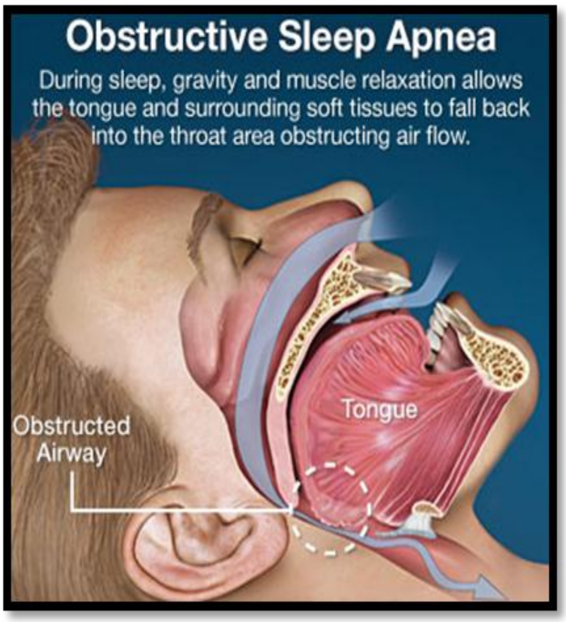

Fig. 1[8]: http://www.quantumday.com/2012/03/breathing-treatment-for-sleep-apnea-may.html

Diagnosis

The gold standard test is polysomnography.[21] Polysomnography provides the apnoeic-hypopnoeic index (AHI) to classify the disorder into mild, moderate, or severe.

The Acoustic reflection test can be used to determine the airway obstruction and also the corresponding effect of mandibular advancement and protrusion on the upper airway.[22]

Lateral Cephalogram is 2D imaging and still very useful to examine upper airway, craniofacial, and soft tissue analysis. Also, the most important cephalometric measurements include posterior airway space, length of the soft palate, and the distance of the hyoid bone measured perpendicular to the mandibular plane.[23,24]

In addition to this, Dynamic MRI and CT scan are also very useful 3D imaging aids for snoring and sleep apnoea patient.[25,26,27]

Twin Block Appliance (TBA) and the Posterior pharyngeal space in the sleep apnoea patient

In 1934 a study done by Robin was published in the American Journal of diseases of children. Robin used an intraoral monoblock mandible advancement appliance in the newborn babies with mandibular deficiency to prevent posterior fall-back of the tongue during sleep and oropharyngeal collapse.[28] Afterward, this concept became the base of the use of the various functional appliance in dentofacial orthopedics. Presently, TBA is the most commonly used functional appliance[12] due to various advantages for skeletal correction in class 2 div 1 growing cases.[29] Indeed, there are only a few studies in the literature available for the evaluation of the effect of TBA in improving the posterior pharyngeal space dimensions in sleep apnoea patients. A study was done by Ashok Kumar Jena and associates in India, to evaluate the efficacy of TBA in the improvement of PAP dimensions among subjects with class 2 malocclusion patients with retrognathic mandible and compare its effect with those of fixed functional appliance, Mandibular protraction appliance- 4 (MPA-4). As a result, they found in their study that both TBA and MPA-4 were effective in improving the DOP among subjects with retrognathic mandible, and improvement was significantly greater with the use of TBA.[12] Likewise, this article is aimed to explore the simultaneous benefits of the use of TBA in sleep apnoea patients for improving symptoms along with skeletal and sagittal corrections and changes in posterior pharyngeal airway dimensions.

CASE REPORT

A 13 years old otherwise medically normal male patient with the chief complaint of forwardly placed upper teeth reported to the Department of Orthodontics and Dentofacial Orthopaedics, KD Dental college Mathura, India. The patient's parents also complained of restless sleep, snoring at night, and sometimes pauses and snorts. Occasional arousal was also reported. Further, clinical examination of the patient revealed Angle's class 2 molar relationship bilaterally, proclined upper incisors with a large overjet of 8 mm, deep overbite of 5 mm, retrognathic mandible, narrow maxilla, and convex facial profile. Clinical and photographic VTO were found positive. After careful evaluation of cephalogram and polysomnographic report, a definite diagnosis of growing patient of skeletal class 2 jaw base relationship, retrognathic maxilla, and mandible, Angle's class 2 div 1 malocclusion with a large overjet, deep overbite, steep mandibular plane angle and mild sleep apnoea (AHI=1) were made.

MATERIAL AND METHODS

Sample description

A growing male Patient with the age of 13 years having Class 2 Div 1 malocclusion with large overjet and deepbite was decided for the TBA therapy in the Department of Orthodontics, KD dental college Mathura. The Pt. was given a twin block appliance with the instructions to wear it 24 hrs a day for 9 months until the patient got the pterygoid reflex. Preoperative and postoperative facial and intraoral photographs taken (figures 5,6,9,10,11,1213).

Polysomnography

Polysomnography[30] was conducted using a computerized Alice 5 system (Philips Respironics, Cedar Grove, New Jersey) for monitoring of sleep disorder in the KD Medical College, Mathura. Previously, Pediatric guidelines for diagnosing SA in children have been published.[34]

Cephalometric evaluation and Landmarks

Preoperative(fig.7) and post-operative Lateral ceph (fig.8) were taken before the start of the therapy and after the completion of the active phase of TBA when sagittal correction achieved respectively. During the procedure, the subject was positioned with his spine erect, the FH plane parallels to the floor and teeth in centric occlusion. The head was immobilized in the cephalostat (Gendex Orthalix 9200) using ear rods and the Nasion holder. The subject was requested to look into the reflection of their eyes in a mirror located 200 cm ahead. A metal thread plumb line in front of the subject was used to bisect the facial reflection and to minimize lateral head rotations (Fig.2). The object source distance was 5 feet. A voltage of 80 Kvp and a current of 10 Map was used to obtain the lateral head film (8x10 inches Kodak film). The exposure time was 1 second. A filter was used to clear soft tissue images. Patient instructions were given not to move the head, tongue, and not to swallow during radiograph exposure. Both the radiographs were taken in the expiration phase of respiration and the same machine with identical exposure parameters. The head films were traced on the acetate matt paper (8 x 10 inches) using an HB pencil over a view box using trans illuminated light in a dark room. Afterward, various landmarks were identified for evaluation.

Fig.2: Cephalostat.

A method for identification of landmarks and evaluation of various linear and angular parameters, reference planes for calculations of posterior pharyngeal airway dimensions, maxillary and mandibular position relative to cranial base and growth pattern of mandible was published.[12] Each parameter was measured four times and a mean value was selected for statistical analysis. See Figures 3 and 4 and tables 1 and 2.

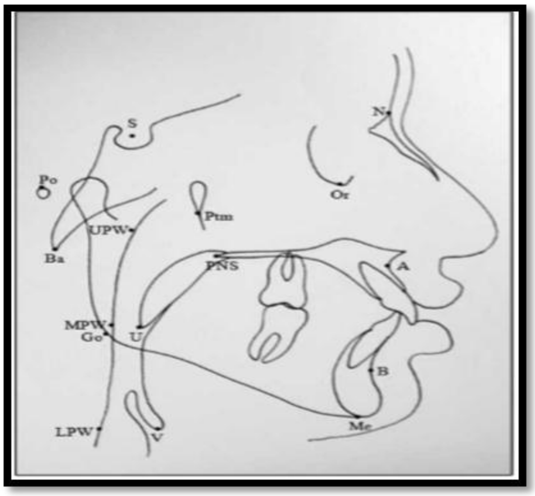

Fig. 3:[12] (REF. Angle Orthodontist, Vol 83, No 4, 2013, DOI: 10.2319/083112-702.1).

Table 1: Various Landmarks Used.

Indication	Landmark
N	Nasion
S	Sella
Me	Menton
Or	Orbitale
Po	Porion
Ba	Basion
A	Point A
B	Point B
Pog	Pogonion

Ptm	Pterygomaxillary fissure
Go	Gonion
PNS	Posterior nasal spine
U	Tip of the soft palate
V	epigliotic vallecula
Upper pharyngeal wall(UPW)	A point at the intersection of Ptm-Ba line and posterior pharyngeal wall
Middle Pharyngeal wall(MPW)	A point at the intersection of the posterior pharyngeal wall and a perpendicular line on the Ptm perpendicular from U or tip of the soft palate
Lower Pharyngeal wall(LPW)	A point at the intersection of the posterior pharyngeal wall and a perpendicular line on the Ptm perpendicular from V or epiglottic vallecula

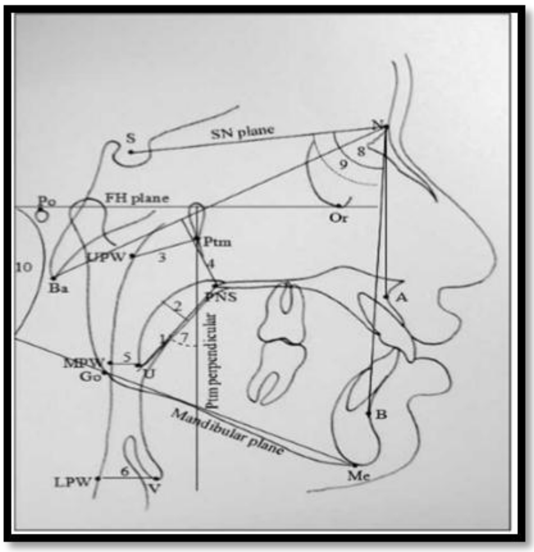

FIG.4:[12] (Angle Orthodontist, Vol 83, No 4, 2013, DOI: 10.2319/083112-702.1).

Table 2: Various Reference Planes, Linear and Angular Parameters Used.

Name	**Reference plane**
S-N Plane	the line joining `S' and 'N';
FH-plane	the line joining 'Po' and 'Or'
Ptm perpendicular	perpendicular plane on FH plane through Ptm
Ba-N plane	a line joining `Ba' and 'N.'
Name	**Linear Parameter**
1. Soft Palatal Length (SPL)	The linear distance between PNS and U, PNS-U
2. Soft Palatal Thickness (SPT)	The maximum thickness of the soft palate
3. Depth of Nasopharynx (DNP)	The linear distance between `Ptm' and `UPW' ((Ptm-UPW),
4. Height of Nasopharynx (HNP)	The shortest distance from PNS to Ba-N plane
5. Depth of Oropharynx (DOP)	The linear distance between U and MPW (U-MPW)
6. Depth of Hypopharynx (DHP)	Linear distance from 'V' to `LPW (V-LPW),
Name	**Angular Parameter**
7. Soft Palate Inclination (SPI)	The angle between Ptm perpendicular and soft palate (Ptm per x PNS-U)
8. SNA	It represents the anteroposterior position of the maxilla to the anterior cranial base
9. SNB	It represents the anteroposterior position of the mandible to the anterior cranial base
ANB	It represents the relative position of maxilla to the mandible
10. FMA	The angle between FH-plane and mandibular plane (Go-Me)

Case Records: Consent taken from both parents and the patient for publication of patient's pictures and radiographs for research education purposes.

FIG. 5: Preoperative facial photographs, Frontal view and profile view.

Fig. 6: Preoperative intraoral photographs.

Fig.7 Preoperative Lateral ceph

Fig.8 Post op lateral ceph

Fig. 9: Postop Facial Photographs: frontal and profile view.

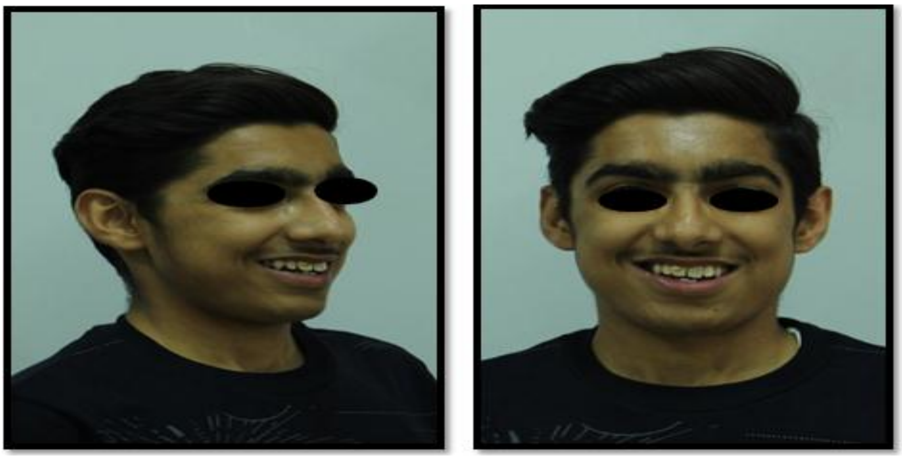

Fig.10: Post op smile Photographs.

Fig.11 Twin Block active phase.

Fig. 12: Postop intraoral Photographs (Frontal and Lateral view).

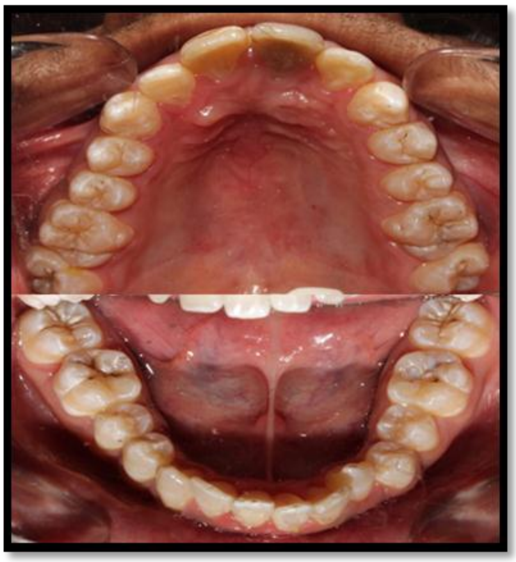

Fig. 13: Postop intraoral Photographs (Occlusal view).

ANALYSIS

Table 3.

Malocclusion	**Age of patient**	**Active TBA Treatment Time**
Skeletal class 2	13 Years (Growing)	9 months
Angle's class 2 div.1		
Polysomnography (PSG)	**AHI = 1**	**Mild Sleep Apnoea Grade 1**

Table 4: Lateral ceph analysis.

Parameters	**Pretreatment (mean value)**	**Post treatment (mean value)**	**P-value**
SNA	79^{O}	80^{O}	.293 (not significant)
SNB	73^{O}	79^{O}	.001
FMA	27^{O}	29^{O}	.005
Soft palatal length SPL (mm)	31.98	29.91	.001
Soft Palatal Thickness SPT (mm)	6.85	8.12	.001
Soft Palatal Inclination SPI	45^{O}	40^{O}	.004
Depth of Nasopharynx (DNP)	13.54	13.75	.060 (not significant)
Height of Nasopharynx (HNP)	20.90	21.10	.303 (not significant)
Depth of Oropharynx (DOP)	7.92	9.64	.002
Depth of Hypopharynx (DHP)	12.86	14.42	.049

RESULT

Detailed Pre-treatment and post-treatment values and changes with parameters are mentioned in table 4 after the treatment duration (table 3). Soft palate length was decreased significantly after the treatment. We found that there was a significant improvement in soft palatal inclination post class 2 correction. There was an increase in soft palatal thickness. There were insignificant changes in dimensions of the depth of nasopharynx and height of nasopharynx, indicative of the minimum effect of TBA therapy on these two measurements. Depth of oropharynx and hypopharynx increased significantly after treatment.

DISCUSSION

At the end of TBA therapy, we found that there was a marked improvement of the sagittal relationship between upper and lower jaws which was expected. Mesial movement of the mandible by TBA changes the position of the hyoid bone and consequently the position of the tongue (through hyoglossus muscle) and thus there was an improvement in morphology and the dimensions of pharyngeal airway.[31] If pharyngeal dimensions are small and established in young children, this may predispose to marked sleep disorders in adults due to soft tissue changes in the pharynx with obesity, age, and genetic predisposition to further reduce the available PPA dimensions.[32] Therefore, it is much beneficial if functional appliance therapy in children results in a permanent improvement in PPA dimensions.[33]

In this presented case, the soft palate was long, thin, and more inclined which might be the cause of mild SA symptoms. The Force generated by the distal position of the tongue in the mandibular retrognathism cases presses soft palate posteriorly may result in a decrease in thickness and increase in length and angulation of soft palate.[34] Marked improvement in soft palate thickness, length, and angulation after the TBA therapy, in this case, maybe explained by the fact that sagittal skeletal correction results in the more anterior displacement of the mandible and thus increased anterior traction of the tongue away from the soft palate leads to the improvement in the soft palate dimensions and inclination.[12] Furthermore, this also explains the significant improvement in the depth of oropharynx and hypopharynx dimensions in the presented case and supported by many previous studies.[35,36,47,38]

This presented case report shows that there was a positive impact of the TBA therapy on the posterior pharyngeal airway dimensions. This can be explained by the fact that not only the skeletal sagittal correction but also gradual simultaneous increase in the tone of Genioglossus muscle and soft tissue changes by the alteration in the posture of the tongue leads to improvement in PPA dimensions.[39] Class 2 correction by TBA therapy in a growing patient may be helpful to eliminate the predisposing factors to obstructive sleep apnoea. Moreover, the literature also supports that the changes in the posterior pharyngeal airway dimensions that occurred by functional appliance therapy including TBA are maintained long termed.[40]

CONCLUSION

This case was treated for the chief complaint of protrusion of upper teeth. The additional benefits of the TBA for PPA dimensions and improvement in SA symptoms were explored by this study. There was a significant improvement in the SA symptoms in this case at the end of active TBA therapy. Soft palate dimensions and inclination were improved. Depth of Oropharynx and Hypopharynx significantly improved. Dimensions of Nasopharynx did not change significantly and thus indicative of the independent growth of the Nasopharynx to the TBA therapy.

MERITS

This study is useful for the effective treatment of lower socioeconomic status patients. The additional benefits of most commonly used appliance, the TBA for PPA dimensions, and improvement in SA symptoms along with skeletal class 2 corrections are explored by this case study and give an idea for further extensive research in this field for an economically weaker segment of the society.

As far as conventional lateral cephalogram is concerned, many limitations are discussed for the radiograph in literature.[41,12] However, the use of lateral cephalograms for airway analysis is an established tool[42] and lateral cephalogram was found to be highly accurate.[43]

LIMITATIONS

Although results are supported by previously published research and studies[12], this is only a single case study, these results can't be generalized for a larger population. Long term follow-up of the case is needed. Further research on large no. of patients with long term follow up is suggested in the field.

Furthermore, 3D Imaging is an appropriate method for evaluation of posterior pharyngeal airway dimensions, but it is also associated with a high dose of radiations, increased cost, and unavailability in various health centers.

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