INFLUENCE OF MYOFUNCTIONAL THERAPY ON OROPHARYNGEAL AIRWAY DIMENSIONS IN SKELETAL CLASS II CASES – A CEPHALOMETRIC STUDY

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Skeletal Class II malocclusion is associated with a multitude of functional problems one of which is reduced oropharyngeal airway dimension. The airway is receiving renewed attention in recent literature regarding snoring and obstructive sleep apnoea syndrome especially as a retrognathic mandible is often implicated as its cause.

The study was undertaken to investigate the myofunctional appliance (TWIN BLOCK) effects on the oropharyngeal airway dimensions in Skeletal Class II individuals in the average age of 11-13 years. This study also expresses the existence of any correlation between airway dimension and craniofacial morphology.

Key words: Skeletal Class II, Twin block, inferior airway space, middle airway space, superior airway space, oropharyngeal airway.

The oral & pharyngeal regions are said to have a primary function in maintaining a patent airway. This is accomplished by dynamic muscle – skeletal balance. In Skeletal Class II cases, the mechanism of airway maintenance is a principal deteriment of the anteroposterior relationship of the placement of tongue. Skeletal Class II malocclusion is associated with a multitude of functional problems, one of which is changes in oropharyngeal airway dimensions. Decreased space between cervical column and mandibular corpus may lead to posteriorly postured tongue and soft palate, increasing respiratory problems in day as well as night

Series of growth studies[1] were conducted on monkeys and rodent to investigate the effect of fixed inclined planes. These studies indicated that functional mandibular position with fixed inclined plane effects on the whole of the dental arch, the condyler head, glenoid fossa & muscle attachment. Even in the adult animals the whole stomatognathic system, including the soft tissues adapt to establish an efficient masticatory system.

Freitas *et al.*(2006)[2] studied on upper & lower pharyngeal airway in subjects with Class I & Class II malocclusion in different growth patterns. The results showed that the upper pharyngeal width in the subjects with Class I & Class II malocclusions with vertical growth pattern group were statistically significantly narrower than in the normal growth pattern group.

Macaedero *et al.*(2009)[3] analyzed the effects of RME & facemask on the sagittal pharyngeal dimensions in subjects with Class III malocclusion when compared with an untreated Class III control group and found Orthopedic treatment of Class III malocclusion does not produce a significant increase in airway dimension in the short term.

The oropharyngeal airway is bound by the glottic aperture below, and it leads into the nasopharyngeal airway above. Thus, portion of upper airway has attracted less attention than its nasal counterpart, yet it plays a vital role in the passage of respiratory gases to and from the lungs. Despite its importance the upper airway has not been studied with reference to facial morphology.

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In the past, removable appliances have been designed which reposition mandible and tongue anteriorly to enlarge the airway space, But the question remains debated regarding the effectivity of myofunctional appliances in altering its dimension.

Thus, the objectives of the present study were:

1- To evaluate the influence of myofunctional appliance therapy on oropharyngeal airway dimensions in Skeletal Class II cases.

2- To compare the oropharyngeal airway dimension in pre and post-treated Class II cases with normal sample.

3- To correlate the craniofacial morphology with oropharyngeal airway dimensions.

MATERIAL AND METHODOLOGY

Initially cases were screened for having maxillary protrusion, retrusive mandible & distal step molar relationship (potential Class II skeletal) in the age group of 11 to 13 years and they were subjected to lateral cephalograms for evaluation of skeletal pattern . 25 patients who had average growth pattern & skeletal Class II, with more than 4° ANB angle were selected and treated with myofunctional (TWIN BLOCK) appliance for 9 to 12 months. Then it was compared with 25 subjects having normal craniomandibular relationship.

Criteria for sample selection

- Skeletal Class II cases .
- ANB > 4 degree
- Overjet >4 mm & overbite > 4mm
- No previous history of any trauma in head and neck region
- Age range: 11-13 years
- X-ray taken in centric occlusion.

The cephalograms of the subjects were categorised into the following three groups.

Group A: Consisting of 25 patients with average growth pattern having skeletal &Angle's Class I molar relationship with excellent occlusion free from any abnormalities in the vertical dimension of facial form.

Group B: Twenty five subjects having Skeletal Class II malocclusion with an average growth pattern & retrognathic mandible.

Group C: Post-treatment cephalograms of all twenty five subjects of Group B having molars established in Class I relationship to ascertain tretment results.

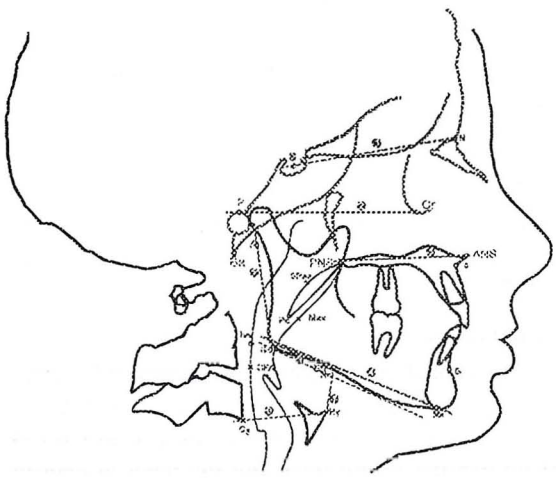
Methodology

The cephalograms obtained were taken by positioning the patients on a universal counterbalancing type of cephalostat with the Frankfort horizontal plane parallel to the floor and the teeth in centric occlusion. Kodak X-ray films (8"x10") were exposed at 70 Kvp; 30 mA from a fixed distance of 60 inches for 1.5 seconds by following the standard technique employed in the Department of Orthodontics, Faculty of Dental Sciences, King George's Medical College, Lucknow. All cephalograms were traced and landmarks were located, the lines & planes as defined were drawn for measurments of angular & linear measurments. Inferior, middle & superio-posterior airway space as defined by Bonham (1988) and Oropharyngeal airway by Trenouth *et al* (1999) were included in the study (Fig.1& 2).

Ias (Inferior Airway Space): The distance between the posterior pharyngeal wall and the dorsal surface of the base of the tongue, measured on the line that intersects gonion and point B (Bonham *et al.*, 1988)[4].

Mas (Middle Airway Space): The distance between the posterior pharyngeal wall and the dorsal surface of the tongue, measured through the posterior tip of the soft palate (P) parallel to the line that intersects gonion and B points (Bonham *et al.*, 1988)[4].

SPas (Superior Posterior Airway Space): The distance between the posterior pharyngeal wall and the dorsal surface of the soft palate measured through



1- SN line
2- FH line
3- Palatal plane
4- Mandibular plane
5- Ar-Go line
6- C_3Hy
7- Hyoid to mandible (Hy-GoMe)
8- Antegonial notch height (NH)
9- Antegonial notch distance (ND)

Fig. 1: Cephalometric Lines and Planes used in the analysis[4, 5, 22]

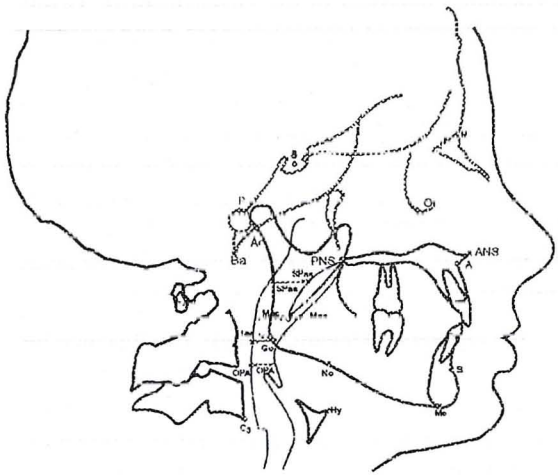


Fig. 2: Cephalometric parameters for Airway Space Analysis[4, 22]

the point midway between PNS and P parallel to the line that intersects gonion and point B (Bonham *et al.*, 1988)[4].

OPA (Oropharyngeal Airway Space): This is at right angle to the airstream approximately between the uvula and epiglottis nearest to epiglottis below Ias (Trenouth *et al.*, 1999)[5]

Negative sign shows decrease in value of the variables at post-treatment.

NS Non-significant value; $p<0.01$ highly significant; $p<0.05$ significant

Table I, II and III presents mean & SD of normal subjects (group A), skeletal Class II patients with average growth pattern before treatment (group B), and after treatment (group C), of linear, angular measurments and airway spaces

Angular, linear and airway spaces in all (Table I, II and III) groups demonstrated mean changes between normal and before treatment i.e malocclusion and changes after treatment and treatment results when compared with normal individuals.

Effect of treatment clearly indicated significant changes in all angular variables Table IV i.e. FMA, NSBa, SNA, SNB, ANB and gonial angle. These changes were observed after the use of twin block for nearly 9 to 12 months in the age group of 11 years and above. The linear variables for NB, Ar-Go, NoH & NoD also demonstrated significant difference after treatment which has been obtained also for Mas, Spas and OPA. Linear variables NOD, antigonial notch, anterior third vertebrae to hyoid (hyoid to base mandible) ,C3Hy and GOMe-Hy & Ias (inferior airway Space) remained unchanged after treatment with Twin block.

Table I. Mean and SD of Pre-treatment and post-treatment value of angular variables

Name of variable	Normal		Pre		Post	
	Mean	SD	Mean	SD	Mean	SD
FMA	26.16	2.23	24.44	3.32	26.46	3.04
NSBa	128.12	3.85	130.88	5.11	132.28	5.23
Max. Mand.	25.32	3.02	25.76	4.60	27.96	4.63
SNA	81.08	2.89	80.60	2.61	80.36	2.72
SNB	77.72	3.35	74.56	3.01	76.72	2.65
ANB	3.68	1.25	5.96	1.62	3.60	1.29
Gonial angle	**126.88**	**4.10**	**125.84**	**8.14**	**128.00**	**6.76**

Table II. Mean and SD of Pre-treatment and post-treatment value of Linear variables

Name of variable	Normal		Pre		Post	
	Mean	SD	Mean	SD	Mean	SD
NB	88.36	4.29	88.76	4.12	92.61	3.67
Go Me	65.00	3.88	64.76	2.95	66.24	3.17
Ar-Go	38.88	2.37	40.08	4.22	41.56	4.16
NoH	1.07	0.53	1.14	0.58	0.79	0.44
NoD	24.40	4.26	23.56	3.80	23.72	3.34
CzHy	31.80	3.29	31.48	5.52	32.12	3.19
GoMe-Hy	10.52	4.36	13.04	4.67	12.12	6.66

Table III. Linear Measurement of Airway Space

Name of variable	Normal		Pre		Post	
	Mean	SD	Mean	SD	Mean	SD
Ias	11,18	2.42	9.96	2.23	10.96	2.17
Mas	12.52	2.65	11.64	2.53	12.84	2.44
Spas	10.92	2.48	9.48	2.49	10.52	2.82
OPA	10.88	1.96	9.28	2.21	10.90	2.17

Table IV. Comparison of Pretreatment/Post-treatment values of craniofacial morphology and airway space with normal group (by Newman Keul's test)

	Pretreatment and Normal	Post-treatment and Normal
Angular variables		
FMA	2.97*	0.52
NSBa	2.89*	4.36**
Max-Mand	0.53	3.18
SNA	0.88	1.31
SNB	5.23**	1.66
ANB	8.16**	0.29
Gonial-Angle	0.79	0.85
Linear Variables		
NB	0.50	4.71
Go-Me	0.36	1.85
Ar-Go	1.63	3.63*
NoH	0.64	2.70
NoD	1.10	0.89
C3Hy	0.39	0.39
GoMe-Hy	2.36	1.50
Airway		
Ias	2.68	0.48
Mas	1.73	0.63
SPas	2.71	0.77
OPA	3.78*	0.05

* significant (p= <0.05); ** highly significant (p= <0.01)

Table V. Correlation coefficient between mean treatment changes in Angular variables and airway changes

Angular variable	Ias	Mas	Spas	OPA
FMA	0.133	0.156	0.100	0.204
NSBa	0.094	0.056	0.007	0.242
Max-Mand	0.010	0.047	0.160	0.261
SNA	0.182	0.168	0.142	0.191
SNB	0.032	0.143	0.081	0.238
ANB	0.055	0.092	0.031	0.270
Gonial-Angle	0.188	0.162	0.014	0.027

Table VI. Correlation between mean treatment change in linear variables and mean airway change

Linear variable	Ias	Mas	SPas	OPA
NB	0.189	0.228	0.321	0.323
Go-Me	0.094	0.166	0.017	0.021
Ar-Go	0.037	0.076	0.019	0.182
NoH	0.374	0.348	0.127	0.156
NoD	0.012	0.218	0.176	0.008
C3Hy	0.325	0.193	0.092	0.150
GoMe-Hy	0.027	0.001	0.004	0.112

Table 6 demonstrates a positive correlation exists between linear & Skeletal measurements with airway spaces.

Table V and VI shows correlation between angular variable (Table V) and linear variables (Table VI) with air spaces i.e. Ias, Mas, Spas & OPA.

The angular variables demonstrated insignificant correlation with air spaces. Results further revealed that maxillary- mandibular length and ANB have relation with oropharyngeal space. While Table VI demonstrated positive correlation between linear measurement with air spaces.It is evident from the table that positive linear relationship exists between NB with OPA, NoH with Ias, Mas, C3Hy & Ias.

In order to ascertain achievements obtained through Twin block appliance, data obtained after post treatment results were compared to that of normal individuals in the same age group. It was demonstrated (Table IV) that NSBA and Ar-Go are significntly different. Difference of nasion sella basion angular measurments, Ar-Go linear measurments after treatment were more than normal individuals. Wheraes before treatment variation was obsered in FMA, NSBA, SNB, ANB & OPA indicating affected area due to Skeletal Class II malocclusion.

DISCUSSION

The challenge of functional therapy is to maximize the genetic potential of growth and guide the growing face and developing dentition towards a pattern of optimal development.

The present study was contemplated to assess the changes taking place in oropharyngeal airway and craniofacial morphology with myofunctional therapy (twin block) by evaluation of pre and post treatment cephalograms in Skeletal Class II, deficient mandible cases and compare with equal number of individuals having Class I molar relationship. After assessing the angular and linear changes in post treatment cephalogram, attempts were made to find out the changes in airway dimension and craniofacial morphology.

Functional appliances are essentially appliances which have their greatest use in Class II div 1 malocclusion patients with underdeveloped mandibles. The greater the amount of growth available, the more favourable the therapeutic results.

Functional appliance therapy aims to improve the functional relationship of dentofacial structures by eliminating unfavourable development factors and improving the muscle environment enveloping the developing occlusion. Through alteration of the position of teeth and supporting tissues, a new functional behaviour pattern or engram is established that can support a new position of equilibrium.

In Skeletal Class II cases, mandible is placed posteriorly and is backwardly rotated. This affects the genioglossus, geniohyoid and pharyngeal wall which affect the dimension of airway So the role of

functional appliance to advance the mandible in anterior position and functional change in orofacial muscle and airway.

Tumer and Gultan (1999)[6] studied functional appliances like twin block and mono block and their effects on skeletal and dentoalveolar structures. They found that mandibular plane angle and gonial angle increased significantly after treatment. In the present study also the mandibular plane angle and gonial angle increased significantly which supports the study of Tumer & Gultan.

The cranial base angle showed a post treatment increase in this study which is in agreement with the study of Trenouth *et al.* (1999)[5] and Courtcny *et al.* (1996)[7]. They found that the width of the oropharynx increases as the cranial base angle opens up. This could be explained as a more posterior positioning of the tempromandibular joint requiring a larger mandible to maintain a normal relation with the maxilla there by increasing the OPA. Woodside *et al.* (1987)[8] stated that temporomandibular joint changes in continuous functional appliance therapy assist in the correction of disproportionate jaw relationships and post treatment values and this almost corresponds to Clark's norms (1995)[9].

In the present study the values of NB and SNB increased and the value of SNA & ANB decreased after treatment. A significant change in these angular measurements is in support with the study of Lund & Sandler (1998)[10]. An improvement in mandibular retrognathia could be demonstrated by the increase in SNB where incisors proclined significantly during treatment, to a statistically significant level. De Vincenzo and Winn (1989)[11] found similar changes in their ccphalometric study of functional appliance. Despite the fact that a restraining effect on the maxilla could not be demonstrated, the forward repositioning of the mandible did result in a significant change in ANB, thus reducing the severity of the Class II skeletal pattern. Ceylan et al (1995)[12] showed that the oropharynx area becomes smaller with the increase of ANB angle.

A significant decrease in the degree of overjet was seen in the post treatment groups. Mills and Mc Culock (1998)[13] believe that the decrease in the degree of overjet is absolutely dependent on the changes of the treatment by the retrusion of upper incisors and protrusion of the lower incisors. However earlier studies claimed that the decrease of overjet results in stimulation of the forward growth of the mandible in addition to the retraction of upper incisors.

Illing (1998)[14] reported a mean reduction in the maxillary mandibular plane angle when treated with Twin block. This could be due to the rotation of the maxillary plane with twin block therapy, which would tend to lower the value of this variable. While on the contrary Brickback[15] reported an increase in the maxillary mandibular plane angle by 2.5° which is in support of our study that maxillary mandibular plane increased after treatment. This could be attributed to increase in total anterior face height due to eruption of molars and reduction of deep bite.

A Significant increase in linear distance of 3.4 mm between nasion & point B after treatment was found in the present the study. This could be due to increased lower anterior face height by eruption of mandibular molar and an increase in total anterior face height. This finding is supported by the study of Webster (1996)[16] and by Lund and Sandler (1998)[10], who concluded that the increase can also be due to the distal movement of the maxillary molar resulting in extrusion of molars in the process.

McNamara (1987)[17] and Lund & Sandler (1998)[10] in their study on twin block found forward growth resulting in repositioning of the mandible by 2.4 mm, measured at Ar-Pog ,and demonstrated an increase in ramal height and mandibular basal length. The present study exhibited a significant increase in basal length of mandible. This is supported by Clark (1995)[1] in which an increase in ramal height of 1.5 mm and mandibular base length by 1.5 mm was observed at a highly significant level ($p<0.01$). Mammandras *et al.* (1990)[18] suggested that individuals having a small mandible in size are likely to benefit more from functional appliance therapy than individuals having normal sized mandible.

A deep antegonial notch is mostly found in short and backwardly placed mandible. After treatment, antegonial notch height decreased significantly, and its distance from gonion showed an insignificant change on treatment, indicating that mandiblar base length increased in myofunctional therapy, thereby causing slight reduction in antegonial notch height. The mandibular growth direction in deep notch patients as measured by the facial axis and the mandibular plane angle, was more vertically directed than the shallow notch patients as studied by Singer *et al.* (1987)[19]. Deep notch individuals have a longer duration of Orthodontic treatment than shallow notch patients.

The purpose of this retrospective study was to test the first part of our hypothesis i.e., will OAW dimensions increase in individuals with retrognathic mandible when they receive functional orthopaedic treatment in the growing age period. Consequent to treatment in Skeletal Class II cases, the present study indicated that the inferior airway space (Ias), middle airway space (Mas), superior posterior airway space (SPas) increased by an average of 1.1 mm which is significant, while the oropharynx (OPA) increased by 1.6 mm after treatment which is highly significant (<0.01). Whereas, correlation of airway with other variables remained statistically insignificant. Ozbek (1998)[20] studied skeletal Class II cases treated with Harvold type of activator with or without occipital high pull headgear. His investigations revealed that those subjects who had relatively smaller oropharyngeal airway dimension and more retrognathic maxillomandibular complexes at the beginning of treatment period were more likely to exhibit significant increase in oropharyngeal airway dimensions.

In the present study the difference between pre treated and malocclusion individuals having Class I excellent occlusion demonstrated significantly higher in SNB, ANB and OPA. This showed that in skeletal Class II cases position of mandible &the dimension of oropharynx is interrelated. SNB and ANB values showed that mandible placed backwardly resulted in narrowing of oropharynx. After treatment this increased towards normal. This was also demonstrated by Trenouth *et al.* (1999)[5], Ozbek *et al.* (1998)[20], Lowe *et al.* (1986)[21] and Bonham *et al.* (1988)[4] who found that in their study with forward movement of mandible & the dimension of airway increases.

This study further indicated the treatment changes produced by twin block myofunctional therapy and their efficacy in affecting the airway reducing the risk of respiratory problems in the future. Furthermore ,design of study, in itself eliminated bias, since the clinicians who treated these cases were unaware of the problem persisting at the time of treatment. Changes in oropharyngeal airway are more likely to occur only if the oropharyngeal airway of Class II group is fairly smaller than the normal group. As oropharyngeal airways in Class II group are not very much different from the normal, hence no relationship exists. Further studies are needed to evaluate whether increasing oropharyngeal airway dimensions by means of functional orthopaedics in cases with skeletal Class II pattern and mandibular deficiency, will prove to have favourable outcomes, such as modification of growth pattern of craniofacial structures and / or a reduced chance of having impaired respiratory function in short and long term.

CONCLUSION

From the present study following conclusions were drawn:

- Skeletal Class II cases successfully treated by myofunctional (twin block) therapy resulted in increase in oropharyngeal airway dimension.
- Insignificant effect was observed in inferior airway space .While, significant increase in middle airway, superio-posterior airway space and in the width of the oropharynx after treatment with twin block were observed.
- Insignificant correlation existed between airway witdh of craniofacial morphology, though narrow airway and posteriorly short mandible exhibited influence on morphology when compared to normal.

- Increase in width of oropharyngeal airway dimension was observed after treatment, which was comparable to width of individuals with excellent occlusion.

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Pierre Fauchard Academy, India Section

SILVER JUBILEE CDE AND CONVOCATION

Mangalore, December 17, 2011

One-day CDE and Silver Jubilee Convocation of PFA India Section will be held on December 17, 2011 at Mangalore. Fellows are requested to make it convenient to participate in large number.

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