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Original Article

Assessment and Comparison of Oropharyngeal Airway Dimensions in Skeletal Class II Cases Treated With Forsus FRD and Twin Block Appliances

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Abstract :

Aims: To assess the changes in the oropharyngeal airway (OAW) dimensions in individuals with retrognathic mandible treated with Forsus FRD and Twin Block appliance to correct the skeletal Class II mal relationship.

Methodology: 40 individuals, with Class II skeletal pattern were selected as per inclusion criteria. Pre-treatment lateral cephalograms and hand wrist radiographs were obtained and analyzed. Group 1 with 20 individuals were treated with Forsus FRD and Group 2 with 20 individuals were treated with conventional Twin Block Appliance. Post treatment records were taken after the Class I molar relationship had been obtained. Pre and post treatment cephalograms were compared and analyzed. The data obtained was statistically evaluated using paired t test and unpaired t test.

Results: On comparison of pre-treatment and post-treatment cephalograms, increase in Oropharyngeal Airway (OAW) measurements, such as Superior posterior airway space (SPAS), Middle airway space (MAS) and Inferior airway space (IAS) was very highly significant.

Conclusion: Our results suggest the existence of a relationship between functional-orthopaedic treatment and increases in OAW dimensions in skeletal Class II growing subjects.

Introduction

Mandibular deficiency has been associated with reduced oropharyngeal airway (OAW) dimensions.[1] Reduced space between cervical column and mandibular corpus may lead to tongue which is positioned posteriorly and soft palate, thereby increasing the chance of impaired respiratory function during the day, and possibly leading to nocturnal problems, such as Upper Airway Resistance Syndrome (UARS), snoring and Obstructive Sleep Apnoea Syndrome (OSAS).[2]

The growth of the skull is closely related to the development and function of the nasal cavities, oropharynx and nasopharynx. In conjunction with the growth of the cranial base and forward development of mid-face the size of the nasopharynx is increased.[3]

An increase in oropharyngeal airway dimensions in growing patients with mandibular deficiency may have some major benefits in terms of craniofacial growth and function. If increases in these dimensions result in an increase in oropharyngeal airway capacity and there by better daytime and nocturnal respiratory function, the possible effect of an impaired oropharyngeal airway function as an etiological factor for abnormalities in facial structures might be reduced and might even modify the vertical and/or sagittal growth pattern of the craniofacial complex.[3]

The mandibular advancement concept is widely used in dentofacial orthopedics to stimulate mandibular growth in skeletal Class II growing cases with mandibular deficiency. For prevention of collapse of the upper airway during sleep, oral appliances are advised in adult obstructive sleep apnoea.[4]

Surgical advancement of the maxilla-mandibular complex has also been proposed to treat certain obstructive sleep apnoea cases with retrognathic facial structures, again by increasing oropharyngeal airway dimensions.[5]

Treatment with functional appliance leads to significant alterations in tongue position and significantly increases the extent of oropharyngeal space.[6]

For growing skeletal class II patients with mandibular retrognathism, treatment modalities to correct the malocclusion include functional appliances, orthognathic surgery when the growth has completed and extraction and retraction of maxillary teeth, which may have deleterious effects on the profile of the soft tissue.[6]

The purpose of this present study is to evaluate and compare the changes in the dimensions of Oropharyngeal airway in growing patients who have skeletal Class II patterns with retrognathic mandibles treated with Forsus FRD and Twin Block functional appliance.

Materials and Methods

This study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, A. B. Shetty Memorial Institute of Dental Sciences, comprising of lateral cephalograms, case history records and clinical records of 40 skeletal class II growing patients.

The sample was divided into 2 groups, group 1 with 20 patients who had undergone Forsus FRD therapy and group 2 with 20 patients who had undergone Twin Block therapy.

Sources of data

Study materials were obtained from the Department of Orthodontics and Dentofacial Orthopaedics, A. B. Shetty Memorial Institute of Dental Sciences, comprising of lateral cephalograms, hand wrist radiographs, case history records and clinical records of 20 skeletal class II growing individuals treated with Forsus FRD and 20 skeletal class II growing individuals treated with Twin Block functional appliance.

Methodology

Inclusion criteria

1. Angle's class II molar relationship with mandibular retrognathism.
2. ANB > 4 degrees.
3. Overjet> 5mm.
4. Significant growth calibre at the start of the treatment period (before MP_{3cap} period).
5. Treatment by forsus FRD and Twin Block with both pre and post treatment records.

Exclusion criteria

1. Known respiratory problems.
2. Obvious naso-oropharyngeal obstruction.
3. Surgical upper airway operations before or during the treatment.

Method of Collection of Data

The individuals fulfilling all of the above mentioned inclusion and exclusion criteria were appealed to take part in the study. Procedures were explained to the selected individuals and standardized pre-treatment and post-treatment lateral cephalograms of each individual subject were obtained.

Radiographs of the handwrist were obtained and analyzed for the growth calibre at the start of the treatment (before MP_{3cap} period).

Cephalometric Analysis

The lateral cephalograms were made under standardized conditions with the Frankfort horizontal plane kept parallel to the floor and the mid-facial plane kept in a vertical position. The tracing of lateral cephalograms were done using 0.003 inch acetate paper with 2H lead pencil. All tracings were done by the same investigator to avoid any kind of inter-operator errors. Armamentarium used for the tracings is shown in (Fig.1).

The following landmarks were traced on the lateral cephalogram. (Fig.2)

1. Sella Turcica (S) - The centre of the pituitary fossa.
2. Nasion (N) - The most anterior point of the fronto-nasal

suture in the median line.

3. Anterior nasal spine (ANS) - The most anterior point on the maxilla at the nasal base.
4. Posterior nasal spine (PNS) – Posterior most point of the palatine bone at the junction of the soft and hard palate.
5. Menton (Me) – The lowest point on the symphysis of the mandible.
6. Gonion (Go) – A point mid-way between the points representing the middle of the curvature at the left and right angles of the mandible.
7. Gnathion (Gn) – The most anterior-inferior point of the chin.
8. Point A – An arbitrary point on the innermost curvature from the maxillary anterior nasal spine to the crest of the maxillary alveolar process.
9. Point B – An arbitrary point on the anterior bony curvature of the mandible. It is the innermost curvature from chin to alveolar junction.
10. Condylion (Co) – The most superior posterior point on the head of the mandibular condyle.

Planes

1. Sella-Nasion plane – Anteroposterior extent of anterior cranial base (S-N)
2. Mandibular plane – Tangent to gonion and lowest point of the symphysis (Go-Me)

Skeletal measurements used in the study

Angular measurements

The following angular measurements were made (Fig.3)

1. Sagittal maxillary position (SNA)
2. Sagittal mandibular position (SNB)
3. Sagittal intermaxillary relation (ANB)
4. Mandibular plane angle (SN-MP)

Linear measurements

The following linear measurements were made (Fig. 3)

1. Maxillary unit length (MxUL)
2. Mandibular unit length (MdUL)
3. Sagittal intermaxillary unit length discrepancy (ULD= MdUL-MxUL)
4. Ratio of upper and lower facial height (UFH/LFH)

Oropharyngeal Airway (OAW) measurements: (Fig. 4)

1. Superior posterior airway space (SPAS): Least distance between the posterior most pharyngeal wall and the posterior border of the soft palate.
2. Middle airway space (MAS): Least distance between the posterior pharyngeal wall and the posterior border of the tongue.
3. Inferior airway space (IAS): Least distance between the posterior pharyngeal wall and the posterior border of the tongue.

Statistical analysis

The study consisted of 2 groups with a sample size of 20 per group. (n)= 40. Significance (p)>0.05 was considered significant. The data obtained was statistically evaluated usingpaired*t*- test and unpaired *t*- test.

Parameters of the study included:

SNA

SNB

ANB

Mandibular plane= SN MP

MxUL

MdUL

ULD=MdUL-MxUL

UFH/LFH

SPAS- Superior Posterior Airway Space

MAS- Middle Airway Space

IAS- Inferior Airway Space

Results

The data collected presented with the following findings: Angular Skeletal measurements for Forsus FRD and Twin Block (Table 2 & 3)

Sagittal maxillary position (SNA)

Forsus FRD: The mean value for SNA pre-treatment was found to be $84.225^0$with SD of 3.164^0; whereas mean value for SNA post-treatment was found to be 84.110^0 with SD of 3.020^0. The difference in mean value for SNA pre-treatment and post- treatment was found to be not significant (p=0.594).

Twin Block: The mean value for SNA pre-treatment was found to be 83.125^{0}with SD of 2.512^{0}; whereas mean value for SNA post-treatment was found to be 83.100^{0} with SD of 2.490^{0}. The difference in mean value for SNA pre-treatment and post- treatment was found to be not significant (p=0.921).

Sagittal mandibular position (SNB)
Forsus FRD: The mean value for SNB pre-treatment was found to be 77.700^{0}with SD of 2.364^{0}; whereas mean value for SNB post-treatment was found to be 79.900^{0} with SD of 2.803^{0}. The difference in mean value for SNB pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Twin Block: The mean value for SNB pre-treatment was found to be 77.050^{0}with SD of 2.328^{0}; whereas mean value for SNB post-treatment was found to be 79.675^{0} with SD of 2.352^{0}. The difference in mean value for SNB pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Sagittal intermaxillary relation (ANB):
Forsus FRD: The mean value for ANB pre-treatment was found to be 6.525^{0}with SD of 1.552^{0}; whereas mean value for ANB post-treatment was found to be 3.800^{0}with SD of 1.271^{0}. The difference in mean value for ANB pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Twin Block: The mean value for ANB pre-treatment was found to be 6.275^{0}with SD of 1.230^{0}; whereas mean value for ANB post-treatment was found to be 3.425^{0}with SD of 1.270^{0}. The difference in mean value for ANB pre-treatment and post- treatment was very highly significant ($p < 0.001$)

Group statistics (Table 1)
While comparing between the 2 appliances, no statistically significant difference was observed, with significance level being (p= 0.357) (Graph 1)

Mandibular plane angle (SN-MP)
Forsus FRD: The mean value for SN-MP pre-treatment was found to be 25.950^{0}with SD of 3.748^{0}; whereas mean value for SN-MP post-treatment was found to be 27.770^{0}with SD of 3.373^{0}. The difference in mean value for SN-MP pre-treatment and post-treatment was very highly significant ($p < 0.001$).

Twin Block: The mean value for SN-MP pre-treatment was found to be 25.450^{0}with SD of 3.993^{0}; whereas mean value for SN-MP post-treatment was found to be 27.050^{0}with SD of 3.364^{0}. The difference in mean value for SN-MP pre-treatment and post- treatment was very highly significant ($p < 0.001$)

Linear Skeletal measurements for Forsus FRD and Twin Block : (Table 6 & 7)
Maxillary unit length (MxUL):
Forsus FRD: The mean value for MxUL pre-treatment was found to be 93.850 mm with SD of 3.6831 mm; whereas mean value for MxUL post-treatment was found to be 94.890 mm with SD of 3.7413 mm. The difference in mean value for MxUL pre-treatment and post- treatment was not significant (p=0.424).

Twin Block: The mean value for MxUL pre-treatment was found to be 93.350 mm with SD of 3.68318 mm; whereas mean value for MxUL post-treatment was found to be 94.15 mm with SD of 3.7931 mm. The difference in mean value for MxUL pre-treatment and post- treatment was not significant (p=0.524).

Mandibular unit length (MdUL)
Forsus FRD: The mean value for MdUL pre-treatment was found to be 109.75 mm with SD of 3.5 mm; whereas mean value for MdUL post-treatment was found to be 111.2 mm with SD of 3.6685 mm. The difference in mean value for MdUL pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Twin Block: The mean value for MdUL pre-treatment was found to be 108.500 mm with SD of 4.568 mm; whereas mean value for MdUL post-treatment was found to be 113.2 mm with SD of 4.668 mm. The difference in mean value for MdUL pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Sagittal intermaxillary unit length discrepancy (ULD= MdUL-MxUL):

Forsus FRD: The mean value for ULD pre-treatment was found to be 15.050 mm with SD of 3.557 mm; whereas mean value for ULD post-treatment was found to be 18.700 mm with SD 4.050 mm. The difference in mean value for ULD pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Twin Block: The mean value for ULD pre-treatment was found to be 14.450 mm with SD of 3.580 mm; whereas mean value for ULD post-treatment was found to be 18.100 mm with SD of 3.972 mm. The difference in mean value for ULD pre-treatment and post- treatment was very highly significant ($p < 0.001$).

While comparing between the 2 appliances, no statistically significant difference was observed, with significance level being ($p= 0.637$) (Graph 2)

Ratio of upper and lower facial height (UFH/LFH):

ForsusFRD: The mean value for pre-treatment UFH/LFH (ratio) was found to be 87.500% with SD of 11.260%; whereas mean value for post-treatment UFH/LFH was found to be 86.850% with SD of 9.178%. The difference in mean value for UFH/LFH pre-treatment and post-treatment was found to be highly significant. ($p< 0.002$)

Twin Block: The mean value for pre-treatment UFH/LFH (ratio) was found to be 86.900% with SD of 11.262%; whereas mean value for post-treatment UFH/LFH was found to be 86.400% with SD of 9.116%. The difference in mean value for UFH/LFH pre-treatment and post-treatment was found to be highly significant ($p < 0.002$).

While comparing between the 2 appliances, no statistically significant difference was observed, with significance level being ($p = 0.877$)

Oropharyngeal Airway (OAW) measurements for Forsus FRD and Twin Block: (Table 8& 9)

Superior posterior airway space (SPAS)

Forsus FRD: The mean value for SPAS pre-treatment was found to be 14.0250 mm with SD of 1.94311 mm; whereas mean value for SPAS post-treatment was found to be 15.750 mm with SD of 2.337 mm. The difference in mean value for SPAS pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Twin Block: The mean value for SPAS pre-treatment was found to be 14.250 mm with SD of 1.916 mm; whereas mean value for SPAS post-treatment was found to be 16.100 mm with SD of 2.315 mm. The difference in mean value for SPAS pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Middle airway space (MAS)

Forsus FRD: The mean value for MAS pre-treatment was found to be 11.700 mm with SD of 1.490 mm; whereas mean value for MAS post-treatment was found to be 12.900 mm with SD of 1.518 mm. The difference in mean value for MAS pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Twin Block: The mean value for MAS pre-treatment was found to be 11.400 mm with SD of 1.536 mm; whereas mean value for MAS post-treatment was found to be 12.800 mm with SD of 1.508 mm. The difference in mean value for MAS pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Inferior airway space (IAS)

Forsus FRD: The mean value for IAS pre-treatment was found to be 9.750 mm with SD of 1.209 mm; whereas mean value for IAS post-treatment was found to be 10.900 mm with SD of 1.071 mm. The difference in mean value for IAS pre-treatment and post- treatment was very highly significant ($p < 0.001$).

Twin Block: The mean value for IAS pre-treatment was found to be 9.200 mm with SD of 1.240 mm; whereas mean value for IAS post-treatment was found to be 11.150 mm with SD of 1.424 mm. The difference in mean value for IAS pre-treatment and post- treatment was very highly significant ($p < 0.001$).

There was statistically significant increase in the oropharyngeal airway space when treated with Forsus FRD and Twin Block appliance.

But there was no statistically significant difference in the dimension of oropharyngeal airway space when compared between Forsus FRD and Twin Block appliance, with a significance level of p= 0.637 for SPAS, p= 0.836 for MAS, p= 0.534 for IAS. (Graph 3 and 4)

Table 1 : Group Statistics for ANB

Group	Variable	N	Mean	Std. Deviation	
Forsus FRD	ANB Post Treatment	20	79.900	2.380	p=0.357
Twin Block	ANB Post Treatment	20	79.675	2.352	

Table 2 : Paired Samples Statistics for Angular Skeletal Measurements

Group	Variable	N	Mean	Std. Deviation
Forsus FRD	SNA Pre-Treatment	20	84.225	3.154
	SNA Post-Treatment	20	83.55	2.929
Twin Block	SNA Pre-Treatment	20	83.125	2.512
	SNA Post-Treatment	20	83.1	2.49
Forsus FRD	SNB Pre-Treatment	20	77.7	2.354
	SNB Post-Treatment	20	79.9	2.38
Twin Block	SNB Pre-Treatment	20	77.05	2.328
	SNB Post-Treatment	20	79.675	2.352
Forsus FRD	ANB Pre-Treatment	20	5.525	1.552
	ANB Post-Treatment	20	3.8	1.271
Twin Block	ANB Pre-Treatment	20	6.257	1.23
	ANB Post-Treatment	20	3.425	1.27
Forsus FRD	SN-MP Pre-Treatment	20	25.95	3.748
	SN-MP Post-Treatment	20	27.77	3.373
Twin Block	SN-MP Pre-Treatment	20	25.45	2.328
	SN-MP Post-Treatment	20	27.05	2.380

Table 3 : Paired Samples Tests for Angular Skeletal measurements

Group	variable	Paired Differences		t	p
		Mean	Std Deviation		
Forsus FRD	SNA Pre-RX- SNA Post RX	6.75	1.280	2.358	0.594
	SNB Pre-RX- SNB Post RX	-2.200	1.207	-8.148	<0.001
	ANB Pre-RX- ANB Post RX	2.725	1.208	10.086	<0.001
	SN/MP Pre-Rx- SN /MP Post Rx	-1.750	1.293	-6.054	<0.0001
Twin block	SNA Pre-RX- SNA Post RX	0.25	1.106	101	921
	SNB Pre-RX- SNB Post RX	-2.625	1.062	11.052	<0.001
	ANB Pre-RX- ANB Post RX	2.850	.651	19.581	<0.001
	SN/MP Pre-Rx- SN /MP Post Rx	-1.600	1.729	-4.138	<0.001

Table 4 : Group Statistics for Sagittal intermaxillary ULD

Group	Variable	N	Mean	Std Deviation	t
Forsus FRD	ULD POST-TREATMENT	20	18.700	4.052	p=0.637
Twin Block	ULD POST-TREATMENT	20	18.100	3.972	

Table 5 : Group Statistics for UFH/LFH

Group	Variable	N	Mean	Std Deviation	t
Forsus FRD	UFH/LFH POST-TREATMENT	20	86.850	9.178	p=0.877
Twin Block	UFH/LFH POST-TREATMENT	20	86.400	9.116	

Table 6 : Paired Samples Statistics for Linear Skeletal measurements

Group	Variable	N	Mean	Std Deviation
Forsus FRD	MxUL PRE - TREATMENT	20	93.85	3.6831
	MxUL POST - TREATMENT	20	94.89	3.7413
Twin Block	MxUL PRE - TREATMENT	20	93.35	3.6813
	MxUL POST - TREATMENT	20	94.15	3.7931
Forsus FRD	MdUL PRE - TREATMENT	20	109.75	3.5
	MdUL POST - TREATMENT	20	111.2	3.668
Twin Block	MdUL PRE - TREATMENT	20	108.5	4.568
	MdUL POST - TREATMENT	20	113.2	4.568

Table 7. Paired Samples Tests for Linear Skeletal measurements

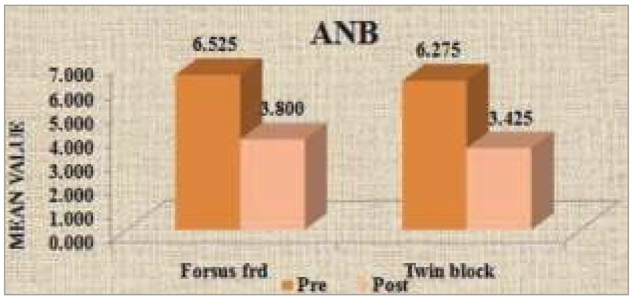
Group	variable	Paired Differences		t	P
		Mean	Std Deviation n		
Forsus FRD	MxUL Pre-Rx-MdUL Post Rx	4.500	7.416	2.714	.014
	MxUL Pre-Rx-MdUL Post Rx	4.500	8.543	.628	.537
	ULD Pre-Rx-ULD Post Rx	-3.650	4.104	-3.977	<0.001
	UFH / LFH PRE Rx-UFH / LFH Post Rx	650	7.862	370	<0.00
Twin Block	MxUL Pre -Rx-MxUL Post Rx	4.450	7.373	2.699	.014
	MdUL Pre-Rx-MdUL Post Rx	900	8.710	.462	.649
	ULD Pre-Rx-ULD Post Rx	-3.650	4.347	-3.755	<0.001
	UFH / LFH PRE Rx-UFH / LFH Post Rx	500	7.871	.284	<0.002

Table 8 : Paired Samples Statistics Oropharyngeal Airway (OAW) Measurement

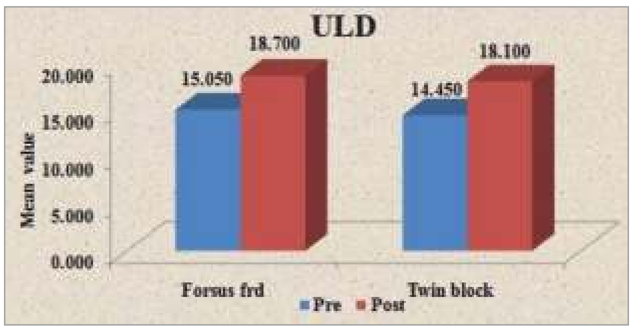
Group	Variable	N	Mean	Std Deviation
Forsus FRD	SPAS PRE-TREATMENT	20	14.25	1.943
	SPAS POST-TREATMENT	20	15.75	2.337
Twin Block	SPAS PRE-TREATMENT	20	14.250	1.916
	SPAS POST-TREATMENT	20	16.110	1.490
Forsus FRD	MAS PRE-TREATMENT	20	11.700	1.490
	MAS POST-TREATMENT	20	12.900	1.518
Twin Block	MAS PRE-TREATMENT	20	11.400	1.536
	MAS POST-TREATMENT	20	12.800	1.508
Forsus FRD	IAS PRE-TREATMENT	20	19.750	1.209
	IAS POST-TREATMENT	20	10.900	1.070
Twin Block	IAS PRE--TREATMENT	20	9.200	1.240
	IAS POST-TREATMENT	20	11.15	1.424

Table 9 : Paired Samples test for Oropharyngeal Airway (OAW) Measurements

Group	variable	PAIRED DIFFERENCE		Std Deviation	
		N	Mean		
SPAS POST TREATMENT	Forsus FRD	20	15.75	2.337	p=0.637
	Twin Block	20	16.1	2.315	
MAS POST TREATMENT	Forsus FRD	20	12.9	1.518	p=0836
	Twin Block	20		12.8	1.508
IAS POST TREATMENT	Forsus FRD	20	10.9	1.071	p=0.534



Graph 1 : Comparison of Pre Treatment and Post Treatment ANB



Graph 2 : Comparison of Pre Treatment and Post Treatment ULD

Graph 3 : Comparison of Pre Treatment and Post Treatment SPAS

Graph 4 : Comparison of Pre Treatment & Post Treatment MAS & IAS

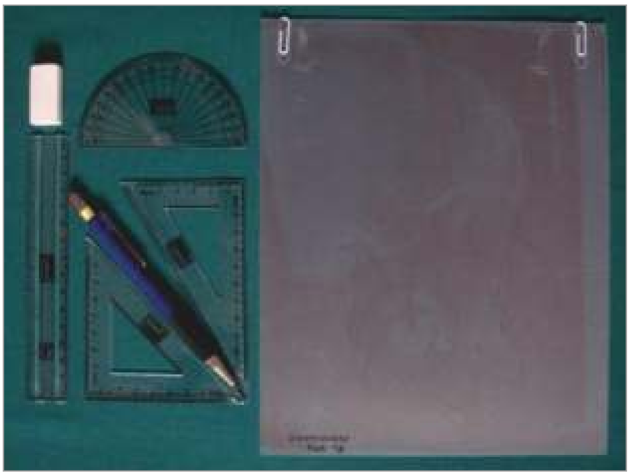


Fig 1 : Armamentarium used for the Study

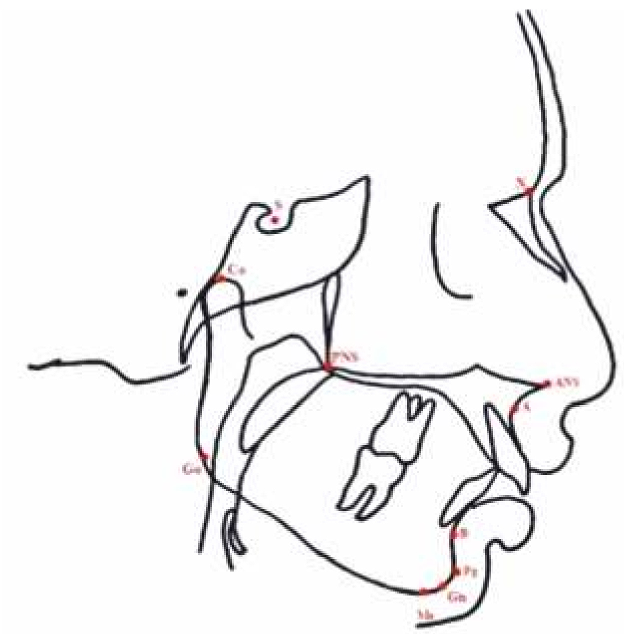


Fig 2 : Landmarks on lateral cephalogram

1. S -Sella Turcica 2. N - Nasion 3. ANS - Anterior
4. PNS - Posterior nasal spine 5. Me - Mention
6. Go - Gonion 7. Gn -Gnathion 8. A - Point A
9. B - Point B 10. Co - Condylion

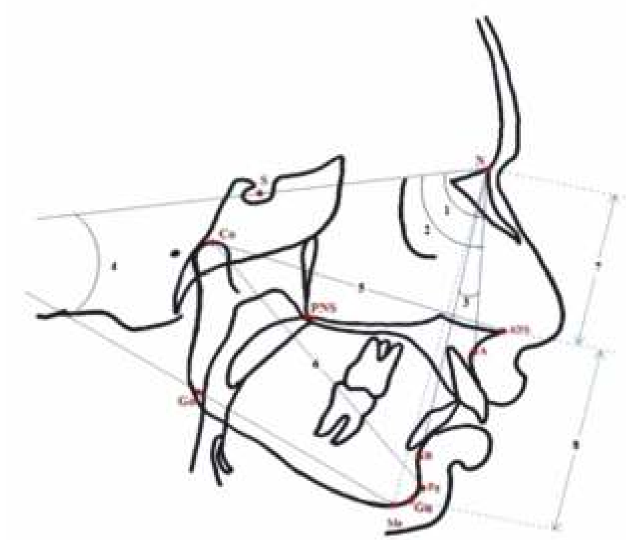


Fig 3 : Linear and angular measurements on cephalogram

1. Sagittal position of maxilla - (SNA)
2. Sagittal position of mandible - (SNB)
3. Sagittal intermaxillary relation - (ANB)
4. Mandibular plane angle - (SN-MP)
5. Length of the Maxillary unit - (MxUL)
6. Length of the mandibular unit - (MdUL)
7. Upper facial height - (UFH)
8. Lower facial height - (LFH)

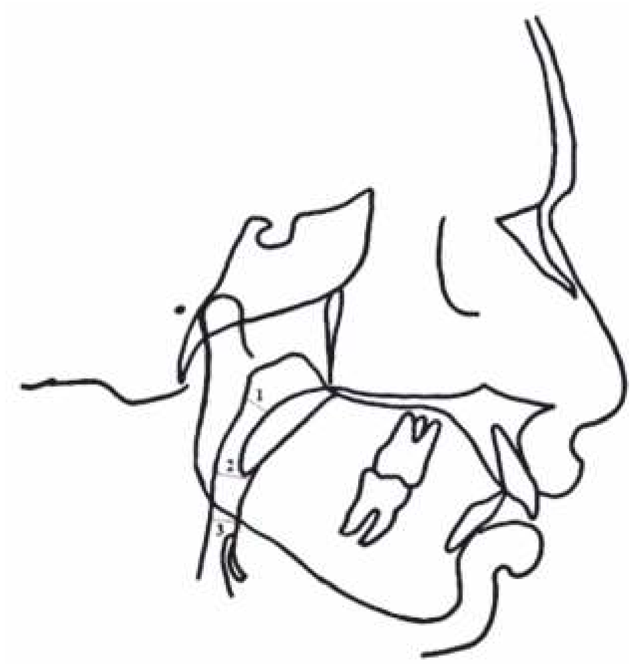


Fig 4 : Oropharyngeal Airway (OAW) measurements

1. Superior posterior airway space (SPAS)
5. Middle airway space (MAS)
3. Inferior airway space (IAS)

Discussion

Decreased space between the cervical column and the mandibular corpus may lead to posteriorly postured tongue and soft palate, increasing the chances of impaired respiratory function during the day, and possibly causing nocturnal problems as well, such as snoring, upper airway resistance syndrome (UARS), and obstructive sleep apnea syndrome (OSAS).[2]

An increase in Oropharyngeal airway dimensions in growing patients with mandibular deficiency may have some major benefits in terms of craniofacial growth and function. If increase in these dimensions result in an increase in Oropharyngeal airway capacity and thereby better daytime and nocturnal respiratory function, the possible effect of an impaired oropharyngeal airway function as an etiological factor for abnormalities in facial structures might be reduced and might even modify the vertical and/or sagittal growth pattern of the craniofacial complex.[3]

Again, if there are no other upper airway pathologies, such as oversized adenoids or tonsils, or chronic respiratory problems, it might reduce the chances of having disturbed respiratory function during sleep, such as snoring, UARS, or OSA. It is not surprising that many orthodontic patients who have a history of snoring at the beginning of functional orthopedic treatment report a reduction in these symptoms, even at the early stages of treatment. This benefit should not be underestimated, as it has been demonstrated that there may be a link between sleep patterns (or stages) and nocturnal release of growth hormone.[7,8]

Any factor that leads to an insufficient sleep pattern may cause a reduction in plasma growth hormone levels, which may, in turn, not only slow down the overall growth rate, but also cause a reduction in condylar activity and thereby, mandibular growth.[3]

A significant relationship is also known to exist between retrognathic maxillary and mandibular structures and OSA in adult patients. Therefore, an additional benefit of early orthopaedic treatment may be that it reduces the chances of having OSA later, if the orthodontist can correct the skeletal pattern and increase oropharyngeal airway capacity permanently, especially in those patients who have retrognathic and small maxillo-mandibular structures and small oropharyngeal airway dimensions.[3]

The Twin-block (TB) appliance, originally developed by Clark, is a widely used functional appliance for the management of class II malocclusion. Narrowing of the pharyngeal airway appears to be improved by mandibular advancement during the first few months of Twin Block treatment. Long-term observation after treatment confirms that the increase in upper pharyngeal width is maintained and lip competence is also achieved consistently during Twin Block treatment.[9]

The Forsus FRD appliance is a fixed functional appliance used for the management of Class II malocclusion. It has a unique co-axial spring design which addresses the issue of fatigue failure – a fracture caused by repeated application of stresses in the coil spring.

Hence in this study an attempt was made to evaluate and compare the oropharyngeal airway changes between Forsus FRD and Twin block appliance.

On comparison of pre-treatment and post-treatment cephalograms, change in sagittal maxillary position (SNA) was found to be not significant in this study between both the groups. This result was similar to the finding observed by M. Murat Özbek et al,[3]

On comparison of pre-treatment and post-treatment cephalograms, change in sagittal mandibular position (SNB) and sagittal intermaxillary relation (ANB) was found to be very highly significant in our study, between both the groups. Similar results were found in the studies conducted by M. Murat Özbek et al[3], S. Yassaei et al, [6]Christine M. Mills et al,[14] David Ian Lund,[15] and Aynur Aras.[17] But there was no significant post treatment changes seen in SNB and ANB using Forsus FRD in the study conducted by Fulya Ozdemira.[18]

On comparison of pre-treatment and post-treatment cephalograms, change in Maxillary unit length (MxUL), was found to be not statistically significant. Change in Mandibular unit length (MdUL) and Sagittal intermaxillary unit length discrepancy (ULD= MdUL-MxUL) was found to be very highly significant. Similar results were found in the studies conducted by M. Murat Özbek et al[3] and Christine M. Mills et al.[14] Highly significant increases in mandibular length was also observed in a study conducted by DeVincenzo,[16] and Aynur Aras.[17]

Change in Ratio of upper and lower facial height (UFH/LFH) was found to be significant in both the groups. These observations are in accordance with the study conducted by M. Murat Özbeket al.[3]

On comparison of pre-treatment and post-treatment cephalograms, increase in Oropharyngeal Airway (OAW) measurements, such as Superior Posterior Airway Space (SPAS), Middle Airway Space (MAS) and Inferior Airway Space (IAS) was found to be very highly significant in both the groups . These observations are in accordance with the study conducted by M. Murat Özbek et al.[3] Significant increase in oropharyngeal space was also observed in the study conducted by S Yassaei et al,[6]and ShirohIsono et al.[11] But there was no significant changes seen in the posterior airway after treatment with Forsus FRD in the study conducted by Fulya Ozdemira.[18] In this study both the groups showed significant increase in the oropharyngeal airway dimensions when the mandible is advanced, but there was no significant difference seen when compared between the two groups.

Conclusion

The conclusions of the study are as follows

1. There was significant increase in the oropharyngeal airway dimensions in individuals who were treated with Twin Block appliance and Forsus FRD in correcting class II skeletal mal relationship; however there was no significant difference observed when compared between the two groups.

2. Both the groups showed significant skeletal changes in the correction of class II mal relationship by forward positioning of the mandible.

Our results clearly suggest the existence of a relationship between functional-orthopaedic treatment and increases in Oropharyngeal Airway dimensions in Skeletal Class II growing subjects. However, it would be premature to arrive at a general clinical conclusion. So, further studies are needed to evaluate if increasing Oropharyngeal airway dimensions by means of functional orthopaedic treatment in cases with Skeletal Class II pattern and mandibular deficiency will prove to have favourable outcomes, such as modification of growth pattern of the craniofacial structures and/or a reduced chance of having impaired respiratory function in short and long-term.

List of Abbreviations

Sl. No	Abbreviations	Full Form
1.	OAW	Oropharyngeal Airway
2.	OSAS	Obstructive Sleep Apnea Syndrome
3.	SNA	Sagittal maxillary position
4.	SNB	Sagittal mandibular position
5.	ANB	Sagittal intermaxillary relation
6.	SN MP	Mandibular plane angle
7.	MxUL	Maxillary unit length
8.	MdUL	Mandibular unit length
9.	ULD	Sagittal intermaxillary unit length discrepancy
10.	UFH/LFH	Ratio of upper and lower facial height
11.	SPAS	Superior posterior airway space
12.	MAS	Middle airway space
13.	IAS	Inferior airway space
14.	MPD	Mandibular Protruding Device
15.	UARS	Upper Airway Resistance Syndrome

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