(International Print/Online Journal)

SJIF IMPACT FACTOR: 5.565
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 7, Issue 1 , Page No: 420-428
January-February 2024

IJMSCR

Unmasking The Effect Of Twin Block Appliance On Pharyngeal Airway

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Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

Introduction: Skeletal Class II malocclusion and respiratory disorders owing to the obstruction of upper airway have often been correlated so, the evaluation of upper and lower airway space should be considered as an integral part of diagnosis and treatment planning to achieve functional balance and stability of the result in such malocclusions.

Objectives: The present study was conducted to assess the changes in the pharyngeal airway dimensions in skeletal Class II division1 patients treated with Twin Block appliance.

Materials and Methods: Pre (T1) and post-treatment (T2) lateral cephalograms of 35 treated patients (Group A) were analyzed for changes in pharyngeal airway dimensions and they were compared with that of 35 untreated adult patients (Group B). T-test was used to assess the significant difference.

Results: A highly significantly increase ($p<.001$) in the anteroposterior dimensions of all the pharyngeal airways, significant decrease ($p<.01$) in soft palate inclination and non significant upward and forward shift of hyoid bone was observed. Oropharyngeal ($p<.001$) and hypopharyngeal ($p<.01$) airway dimensions increased significantly in group A (T2) when compared with group B.

Conclusion: All pharyngeal airway dimensions improved following Twin Block appliance treatment. Comparing to the untreated adult patients, oropharynx and hypopharynx of treated patients showed a significant enlargement.

Keywords: Cephalometric, Class II division1 malocclusion, Pharyngeal airway, Twin block

Introduction

Skeletal Class II malocclusion and respiratory disorders owing to the obstruction of upper airway have often been correlated. Skeletal features such as retrusion of maxilla and mandible and vertical maxillary excess in hyperdivergent patient may lead to narrower anteroposterior dimensions of the airway. The posterior positioning of the hyoid bone in Class II malocclusion has also been linked to narrower upper airway.[1] Literature also supports the notion of narrow pharyngeal airway passage and anatomical adaptations in pharyngeal airway passage among subjects with retrognathic mandible.[2] Decreased space between the cervical column and the mandibular corpus may lead to a posteriorly postured tongue and soft palate which increases the chances of impaired respiratory function during the day and possibly causing nocturnal problems such as snoring, upper airway resistance syndrome (UARS) and obstructive sleep apnea syndrome (OSAS).[2] Hence, the evaluation of upper and lower airway space should be considered as an integral part of diagnosis and treatment planning to achieve functional balance and stability of the result. Since, there are only few studies[2-6] that mention the pharyngeal airway passage dimension changes following functional appliance treatment, the present study was undertaken to evaluate the efficacy of the Twin-Block appliance in the improvement of pharyngeal airway dimension in growing Class II division1 malocclusion patients and also to compare its effects with those of untreated Class II adult patients.

Materials and Methods

A total of 70 subjects who had skeletal Class II division1 malocclusion were included in the study. The inclusion criteria was:

1. Skeletal Class II Division1 malocclusion with retrognathic mandible.
2. ANB ≥ 4 degrees.
3. Overjet ≥ 5mm.
4. Angle Class II molar relationship with well aligned dental arches with no or minimal crowding or spaces.

Exclusion Criteria:

1. No known Respiratory problems.
2. No obvious naso-oropharyngeal obstruction.
3. No surgical upper airway operations before or during the treatment.

The whole sample was divided into two groups:-

Group A (Twin block group) consisted of 35 growing patients who had Class II Division1 malocclusion and were treated with Twin block Functional appliance.

Group B (Adult Class II subjects) consisted of 35 adult patients who had skeletal Class II Division1 malocclusion (CVMI stage≥6) without any orthodontic treatment.

Lateral cephalograms (Pre-treatment T1 and Post-treatment T2) of Group A were collected from the pre-existing records from the hospital and those of Group B were recorded in due course of time. These cephalograms were analyzed for changes in pharyngeal airway dimensions. Each radiograph was taken with the subjects oriented in Natural Head Position. All the tracings were done[I] by same operator. Where the bilateral structures casted double shadows on the film, the average of the two images was taken. In the cephalometric analysis, pharyngeal airway measurements and hyoid bone position measurements were made as shown in Figure 1.

Observations and Results

Pre and post treatment lateral cephalometric values were measured on lateral cephalograms and their significance were compared using the standardized student 't' test in order to obtain the difference. Paired t test was used to assess difference in the amount of change in the different variables between the pre (T1) and post-treatment (T2) in Group A and unpaired t test was used to compare the changes in group A (T2) and group B. Significance was determined at p< 0.05 (*significant), p<0.01(**highly significant), and p<0.001 (***very highly significant) level of confidence.

The increase in all pharyngeal airway dimensions DNP, DOP and DHP by 1.886±2.774mm, 2.429±1.960mm and 2.629±3.246mm was found to be statistically very highly significant (p= 0.000) in group A pre and post treatment. The decrease in SPI by 2.714±4.383^{0}was statistically highly significant (t=3.664, p= 0.001). The hyoid bone shifted upward and forward but the change was statistically not significant (Table 1a, 2a).

By comparing group A(T2) and group B, we observed a significant improvement in SNB, ANB and Overjet in Group A(T2) (p<.001). A significant enlargement in DOP and DHP after Twin Block treatment was observed (p=000). No significant change in soft palate dimensions and hyoid bone position was observed in two groups (Table 1b, 2b).

Table 1a: Comparison of Pharyngeal Airway measurements of group A (T1) and (T2)

S. No.	Variable	T1 (Mean±SD)	T2(Mean±SD)	Difference (Mean±SD)	Paired t	P Value	Significance

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1.	SPL (mm)	37.17±3.276	36.97±4.693	.200±3.160	.374	.710	NS
2.	SPT (mm)	7.94±1.211	7.97±1.150	-.029±.985	-.172	.865	NS
3.	SPI (^{o})	42.97±5.255	40.26±4.755	2.714±4.383	3.664	.001	**
4.	DNP (mm)	16.54±4.520	18.43±4.984	-1.886±2.774	-4.022	.000	***
5.	HNP (mm)	25.06±2.400	25.40±2.329	-.343±1.830	-1.108	.276	NS
6.	DOP (mm)	8.80±2.233	11.23±2.390	-2.429±1.960	-7.332	.000	***
7.	DHP (mm)	14.46±3.128	17.09±3.649	-2.629±3.246	-4.791	.000	***

Table 1b: Comparison of pharyngeal airway measurements between Group A (T2) and Group B

S. No.	Variable	Group A(T2) (Mean±SD)	Group B (Mean±SD)	Mean Difference	Unpaired t	P Value	Significance
1.	SPL (mm)	36.97±4.693	37.29±4.141	-.314	-.297	.767	NS
2.	SPT (mm)	7.97±1.150	7.86±.912	.114	.461	.647	NS
3.	SPI (^{o})	40.26±4.755	42.57±5.720	-2.314	-1.841	.070	NS
4.	DNP (mm)	18.43±4.984	20.26±5.124	-1.829	-1.513	.135	NS
5.	HNP (mm)	25.40±2.329	27.00±3.464	-1.600	-2.268	.027	*
6.	DOP (mm)	11.23±2.390	8.71±2.480	2.514	4.319	.000	***
7.	DHP (mm)	17.09±3.649	14.51±2.801	2.571	3.307	.002	**

*= p<0.05, ** = p<0.01, ***= p<0.001, NS=Not significant

Table 2a: Comparison of Hyoid bone position measurements of Group A, (T1) and (T2)

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S. No.	Variable	T1 (Mean±SD)	T2(Mean ±SD)	Difference (Mean±SD)	Paired t	p Value	Significance
1.	HRGN (mm)	35.69±7.443	36.71±5.829	-1.029±5.727	-1.063	.295	NS
2.	C_3H (mm)	33.49±3.551	34.23±3.858	-.743±3.845	-1.143	.261	NS
3.	HH1 (mm)	4.80±3.716	4.69±3.521	.114±4.028	.168	.868	NS
4.	MPH (mm)	14.40±5.735	12.71±4.926	1.686±5.051	1.974	.057	NS

*= p<0.05, ** = p<0.01, ***= p<0.001, NS=Not significant

Table 2b: Comparison of hyoid bone position measurements between Group A (T2) and Group B

S. No.	Variable	GroupA(T2) (Mean±SD)	Group B(Mean±SD)	Mean Difference	Unpaired t	P Value	Significance
1.	HRGN (mm)	36.71±5.829	36.34±5.630	.371	.271	.787	NS
2.	C_3H (mm)	34.23±3.858	35.14±4.447	-.914	-.919	.361	NS
3.	HH1 (mm)	4.69±3.521	6.60±4.906	-1.914	-1.875	.065	NS
4.	MPH (mm)	12.71±4.926	14.49±6.51	-1.771	-1.284	.204	NS

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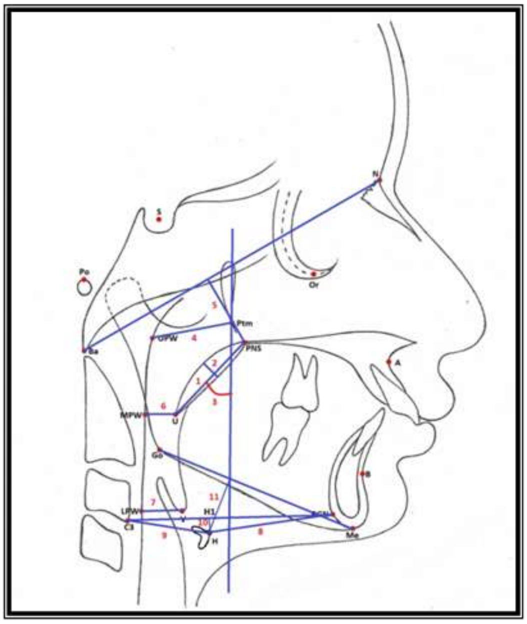
*= p<0.05, ** = p<0.01, ***= p<0.001, NS=Not significant

Figure 1: Pharyngeal airway measurements and hyoid bone position[6]. 1.SPL: Soft palate length: (U–PNS) indicates linear distance between U and PNS. 2.SPT:Soft palate thickness: the maximum thickness of the soft palate. 3.SPI: Soft palate inclination; (Ptm per X PNS-U), the angle between Ptm perpendicular and soft palate (PNS-U). 4.DNP: Depth of Nasopharynx: (Ptm–UPW), linear distance between 'Ptm' and 'UPW'. 5.HNP:Height of Nasopharynx: the shortest linear distance from PNS to Ba-N plane. 6. DOP: Depth of oropharynx: (U–MPW), linear distance between 'U' and 'MPW'. 7.DHP:Depth of hypopharynx: (V–LPW), linear distance from'V' to 'LPW'. 8.HRGN[1]: Distance between hyoid bone and RGN. 9.C_3H[1]: Distance between hyoid bone and C_3. 10.HH_1[1]: Perpendicular distance of hyoid bone to line connecting C_3 and RGN. 11.MPH[1]: Perpendicular distance of hyoid bone to mandibular plane.



Discussion

It is observed that the patients with skeletal class II malocclusion with deficient mandible can have a tendency for breathing problems.[7] In as tudy using cone- beam computed tomography imaging, children classified with skeletal class II malocclusions also had smaller pharyngeal airway dimensions than children with skeletal Class I malocclusion.[8] Without therapeutic intervention, voluntary anterior-posterior compensation does not occur with normal growth of mandible in Class II malocclusion.[9,10] Therefore, children with skeletal Class II malocclusion may have a higher probability of maintaining the skeletal phenotype, even after growth, as they have smaller pharyngeal airway dimensions than children with Class I malocclusion.[11]

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.[12]

It has been well documented that without therapeutic intervention, voluntary anterior-posterior compensation does not occur with normal growth of mandible in Class II malocclusion.[9,10] There is an inverse relationship between the length of soft palate (SPL) and sagittal mandibular development. The increased length of soft palate among subject with mandibular retrognathism could be the result of

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backward position of the tongue, which compressed the soft palate and resulted in decreased thickness and increased length of soft palate. Muto et al[4] also observed that a long soft palate was associated with smaller oropharyngeal depth. The results of this study were in accordance with an earlier study.[13] However, in contrast to our observations many investigators[2,14,15] reported statistically significant improvement in soft palate dimensions upon mandibular advancement. These changes were probably due to the anterior displacement of the mandible, which caused anterior traction of the tongue away from the soft palate and changed the soft palate dimensions.[2] It has been demonstrated that the more backward positioning of the tongue among mandibular retrognathism subjects pushed the soft palate backward and increased its inclination.[6] Muto et al[13] also observed maximum inclination of soft palate among subjects with mandibular retrognathism, followed by those with a normal mandible and those with mandibular prognathism. The improvement in soft palate inclination (SPI) could be explained by the fact that anterior displacement of mandible by Twin Block appliance caused more anterior traction of the tongue away from soft palate, which allowed the soft palate to hang freely and thus reduced the inclination. Jena et al[2] also reported similar observation following Twin Block appliance treatment in Class II subjects.

The increase in DNP was found to be very highly significant (p=.000) (Table 1a). Many investigators[14,16,17,18] have also reported similar observations following various functional appliance therapy. However, several previous studies[2,11] did not demonstrate any statistically significant increase in nasopharyngeal airway dimension following functional appliance treatment in skeletal Class II malocclusion cases.}A statistically very highly significant increase in DOP was observed in the study. These results were similar to several other studies[12,5,14,17,19]. It is known that in subjects with mandibular retrognathism, the tongue position is more backward, with contact to the soft palate resulting in posterior displacement of soft palate and narrowing of oropharyngeal airway.[13] Mandibular advancement by Twin Block appliance cause relocation of tongue anteriorly and lead to increase in DOP. Oral appliances also act to return the upper airway towards a normal configuration and pattern of muscle function in OSA patients and thus lead to increase in oropharyngeal dimensions in these patients.[19]

A statistically very highly significant increase in DHP was observed in group A (T1) to (T2) (p=.000) (Table 1a). Similar results were reported by many previous studies[2,20] following various functional appliance treatment. This improvement in hypopharyngeal airway might be due to mandibular repositioning.[20]

A statistically very highly significant increase of 2.629±3.246mm in DHP was observed in group A (T1) to (T2) (p=.000) (Table 1a). The explanation for this could be that the lower pharyngeal dimensions are established early in life[21]and Class II dentoskeletal disharmony does not tend to self-correct with natural growth[22] and thus, as mentioned in other studies[8], the airway of class II patients without treatment would keep narrower than in class I patients.

Hyoid Bone Position Measurements:

After treatment with Twin Block appliance, hyoid bone shifted anteriorly but the results were statistically insignificant. (Table 2a). However, many studies[23-25] reported statistically significant forward movement of hyoid bone following functional appliance treatment. In vertical plane, although the hyoid bone was moved upward with respect to the mandibular plane in group A following Twin Block appliance treatment yet the results were statistically not significant (p=.057) (Table 2a). This might be explained by the fact that as the hyoid bone is attached to the mandible by geniohyoid, mylohyoid and the anterior belly of digastric muscle which are responsible for downward movement of the mandible, treatment with Twin block appliance results in hyperactivity of these muscles. Therefore, the balance between the suprahyoid and infrahyoid muscle is disturbed, resulting in upward movement of hyoid bone, while forward mandibular displacement occurs with functional appliance therapy.[24] These results were coincident with the several previous studies.[23,24] However, there were some studied[20,26] which did not support our observations. It had been suggested earlier that both stability and potency of the pharyngeal airway were primary factors in hyoid bone positioning.[27] On the other hand, upward elevation of the hyoid bone occurs with mandibular advancement and this change is transitory in nature.[27,28] As the measurements were taken immediately following treatment in the present study, and in long run, the hyoid bone could move downward as a compensatory action. So, this requires further investigations with long time period of follow up in the future.

On comparison of group A (T2) with that of group B, the hyoid bone remained low by the mean difference of 1.771mm in group B from the mandibular plane, though the results were not statistically significant (p=.204) (Table 2b). It has been demonstrated that the hyoid bone and its musculature occupy a key role in regulation of the pharyngeal airway[29] and its position is affected by the location of both the mandible and the tongue. Also, a low position of the hyoid bone is found to be one of the distinguishing cephalometric feature of OSA.[30,31] Thus, after treatment with Twin block appliance, the anterior displacement of mandible and anterior and superior displacement of hyoid caused an anterior traction of the tongue, which might lead to increased posterior airway space and reduced airway resistance.

Hence, Twin Block functional appliance used for the treatment of Class II division1 malocclusion in growing patients not only improves the facial esthetics but also increases the pharyngeal airway spaces. The increased pharyngeal airway and improved sagittal relation between the jaws due to myofunctional therapy indicates that it is an important mode of correction for patients suffering from airway obstruction with retrognathic mandible. It may reduce the probability of patients undergoing surgical correction for airway obstruction at a later date. Literature also supports the fact that changes in pharyngeal airway passage following functional appliance therapy are maintained in the long term.[32,33] Thus, Class II correction by Twin Block appliance during childhood might also help to eliminate the predisposing factors to obstructive sleep apnoea and may serve to decrease the risk of OSA development in adulthood.

Conclusion

The following conclusions were drawn on the basis of findings of this study:

1. Skeletally, SNB increased significantly and ANB decreased significantly. A significant decrease in Overjet following treatment with Twin Block appliance was observed.
2. The anteroposterior dimensions of all the pharyngeal airways (nasopharynx, oropharynx and hypopharynx) increased significantly. Soft Palate inclination decreased significantly as the mandible is positioned forward. Hyoid bone shifted non-significantly forward and upward in horizontal and vertical dimensions respectively following Twin Block appliance treatment.
3. Depth of Oropharynx (DOP) and depth of hypopharynx (DHP) increased significantly after treatment with Twin Block appliance when compared to group B.

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