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Role of herbst and fixed mechanotherapy in pharyngeal airway volume among class II patients

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Abstract
Aim: To evaluate the role of herbst and fixed mechanotherapy in pharyngeal airway volume among class II patients.
Materials and Methods: This comparative study was conducted among sample of 20 Class II patients selected from department OPD; divided into 2 Groups i.e. Group I (10 patients) treated by Herbst appliance; Group II (10 patients) treated by fixed mechanotherapy. Pharyngeal airway volume, length and width evaluation was done using CBCT.
Results: Significant increase in nasopharyngeal, velopharyngeal, glossopharyngeal, laryngopharyngeal and total airway volume in Herbst group was observed. Velopharyngeal length, glossopharyngeal length and nasopharyngeal airway width showed significant increase in Herbst group.
Conclusion: Herbst therapy induces repositioning of tongue resulting in increased length due to posterior fall of uvula, hence airway volume increases drastically.

Keywords: airway volume, herbst appliance, class II malocclusion, retrognathic mandible

Introduction

Angle showed that Class II division 1 malocclusion is associated with obstruction of the upper pharyngeal airway and mouth breathing [1]. Patients with retrusive mandibles can have breathing problems due to reduced airway volumes [2]. Skeletal Class II malocclusion has always been an intractable challenge for orthodontic practitioners because it presents with both sagittal and vertical discrepancies, these unfavourable discrepancies could lead to lower hyoid bone position with subsequent reduction of pharyngeal airway space and eventual occurrence of obstructive sleep apnea [3]. Pharyngeal airway obstruction is expected to improve with forward jaw movement such as after maxillo-mandibular advancement surgery or with mandibular advancement oral appliances [4]. Herbst appliance is rigid fixed functional appliance for treating Class II malocclusion. The original bite jumping mechanism was developed by Herbst, and the banded design of appliance was reintroduced in late 1970s by Pancherz [5, 6]. Also effect of continuous bite jumping with the Herbst appliance on the occlusion and craniofacial growth were observed. Schultz *et al.* reported that pharyngeal airway volume increases when Herbst appliance and rapid maxillary expander are used together, resulting in relief of obstructive sleep apnea symptoms [7]. This study aimed to evaluate the effect of Herbst appliance on pharyngeal airway dimension in Class II malocclusion patients and its comparison with fixed mechanotherapy using CBCT.

Materials and Methods

20 Class II growing patients who reported to the department of orthodontics for routine fixed mechanotherapy treatment. Inclusion criteria was patients with Class II malocclusion having retrognathic mandible, CVMI stages 2, 3, 4, age 9-12 years, horizontal or average growth pattern, minimum crowding in dental arches. Exclusion criterion was CVMI stage ≥5, ANB ≤4, moderate or severe crowding, missing first permanent molar or any systemic disease.
Group 1 patients were treated by Herbst appliance and Group II by fixed mechanotherapy. Pre and post-treatment CBCT scans were taken before treatment and at end of 8 months (when the appliance was removed). Group II data was selected from department databank which suitably matched with regards to CVMI status.

Airway Evaluation

For evaluation of airway volume, the DICOM images of subjects were imported into InVivo Dental 5.1 where it was possible to orient all three planes, the intersection of these axes appeared at same X,Y and Z coordinates when viewed on respective axial, sagittal and coronal sections. For this study; the airway evaluation was done for total airway volume and at nasopharynx, velopharynx, glossopharynx and laryngopharynx level.

Statistical Analysis

The software used for statistical analysis was SPSS (Statistical package for social sciences) version 24. Correlation of Airway volume with Airway length and width parameters in Group I and Group II were carried out using Pearson's correlation test.

Results

Airway volume, airway length and airway width changes following treatment with Herbst appliance and fixed mechanotherapy are shown respectively in [Table 1], [Table 2], [Table 3]. There was significant increase in nasopharyngeal, velopharyngeal, glossopharyngeal, laryngopharyngeal airway volume in Group I whereas there was statistically significant increase in only airway volume, length, width of velopharyngeal in mechanotherapy group (Group II). Statistically significant increase in total airway volume was produced by Herbst appliance when compared to mechanotherapy group.

In Group 1, significant correlation was found between change in nasopharynx airway volume with nasopharyngeal airway length L1, and nasopharyngeal width W1 and was statistically significant (p≤0.01). The glossopharyngeal airway volume changes correlated significantly with changes in length of velopharyngeal (L2) and glossopharyngeal (L3), laryngopharyngeal airway (L4). Also, change in glossopharyngeal airway volume was also significantly correlated with change in width of nasopharyngeal (W1) and velopharyngeal airway (W2).

Table 1: Comparison between Group I and Group II for effective Airway volume (c.c.) changes

Parameters	Group I (Herbst group)		Group II (Mechanotherapy Group)		p-value
	Pre-Post Change				
	Mean Difference	S.D	Mean Difference	S.D	
Nasopharynx	0.91	1.16	0.16	0.92	0.077
Velopharynx	3.18	2.36	2.73	1.89	0.592
Glossopharynx	2.79	2.95	0.8	1.48	0.034
Laryngopharynx	1.13	1.82	0.46	1.59	0.327
Total airway volume	8.07	5.12	4.21	1.85	0.22

Table 2: Comparison between Group I and Group II for effective Airway length (mm) changes

Parameters	Group I (Herbst group)		Group II (Mechano-therapy Group)		p-value
	Pre-Post Change				
	Mean Difference	S.D	Mean Difference	S.D	
L1: Nasopharyngeal Airway (along palatal plane) (mm)	1.53	3.47	2.24	3.46	0.627
L2: Velopharyngeal length (mm)	4.35	4.96	1.80	2.42	0.149
L3: Glossopharyngeal length (mm)	2.57	4.28	0.06	3.77	0.147
L4: Laryngopharyngeal length (mm)	0.64	4.12	-0.91	2.04	0.277
L5: Nasopharyngeal length (along PNS to cranial base) (mm)	1.09	3.23	-0.13	1.08	0.350

Table 3: Comparison between Group I and Group II for effective Airway width (mm) changes

Parameters	Group I (Herbst group)		Group II (Mechano-therapy Group)		p-value
	Pre-Post Change				
	Mean Difference	S.D	Mean Difference	S.D	
W1: Nasopharyngeal Airway (along palatal plane) (mm)	1.45	2.19	2.00	2.95	0.595
W2: Velopharyngeal length (mm)	1.00	5.62	4.17	4.09	0.140
W3: Glossopharyngeal length (mm)	1.04	6.38	-1.29	2.55	0.908
W4: Laryngopharyngeal length (mm)	1.29	3.51	1.04	3.56	0.866
W5: Nasopharyngeal length (along PNS to cranial base) (mm)	-0.16	1.50	-0.40	1.61	0.707

Discussion

Significant increase in nasopharyngeal airway volume was observed which correlates with findings of Schutz *et al* [7], Restrepo *et al* [8] reported a significant increase in nasopharyngeal airway using bionator appliance. However, the findings showed disagreement with that of Jena *et al*. who conducted a three dimensional study and found no significant change in the dimensions of nasopharyx among Class II subjects [9].

Furthermore glossopharyngeal region is the narrowest part of cross-section in Class II patients and is to be considered clinically important in terms of airway flow and oxygen saturation. Glossopharyngeal airway region has been reported to increase by 0.5 mm during growth.[10] Glossopharyngeal and laryngopharyngeal airway volume increased significantly in our study in herbst group and is supported by findings of Kaoy *et al* [11] and Zhao *et al* [12] in their study.

Kannan *et al* [13] reported significant increase in nasopharynx, oropharynx and hypopharynx airway following treatment with various removable functional appliances whereas decrease or insignificant change was observed with FMA, MPA IV, and herbst appliances which is in contrast to present study findings. Vompi *et al* [14] found significant improvement in pharyngeal airway length, width and depth following functional appliance therapy. Moro *et al* [15] concluded that rigid fixed functional appliances provide better skeletal results than flexible and hybrid ones.

Nasopharyngeal length was found to be highly correlated with change in nasopharyngeal airway volume. Herbst therapy induces the repositioning of tongue resulting in increased length due to posterior fall of uvula, hence airway volume increases drastically. Increased nasopharyngeal width (W1) also showed a strong correlation with nasopharyngeal and total airway volume in the present study.

The mandibular advancement appliance appears to enlarge pharyngeal airway width to a greater degree than length at velopharyngeal and glossopharyngeal levels. Han *et al*.[16]concluded that increase in upper oropharyngeal length was 0.8 mm in skeletal Class I subjects, while bionator showed an increase which was as large as 2 mm during the same period in Class II subjects. Fixed mechanotherapy patients also showed significant improvement in velopharyngeal airway length (L2) in this study.

Glossopharyngeal length and glossopharyngeal and total airway volume were strongly correlated and were responsible for improvement in tongue position, resulting in enhanced airway passage. Ryan *et al* [17] reported that when the mandible is advanced with a mandibular advancement oral appliance, most of velopharyngeal airway enlargement is in the lateral dimension, which is in contrast with the present study findings. Valiathan *et al* [18] reported a positive correlation between the pharyngeal airway and length and position of mandible in fixed orthodontic patients.

Conclusion
Herbst appliance therapy resulted in significant increase in the Pharyngeal airway volume in nasopharyngeal, velopharyngeal, glossopharyngeal and laryngopharyngeal airway levels. Significant change in the length and widths of nasopharyngeal, velopharyngeal, glossopharyngeal and laryngopharyngeal airway were observed using herbst appliance. Herbst therapy resulted into change in position of Hyoid bone which in turns caused modulation of pharyngeal muscles, leading to increase in the airway volume.

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