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Alterations in oropharyngeal airway volume and dimensions following treatment with mandibular anterior repositioning in class II malocclusion

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Abstract

Background: The use of functional appliances has shown to be an effective treatment strategy that improves the profile and corrects the relative position of mandible compared to maxilla in subjects with Class II malocclusion. One such well-accepted appliance is Mandibular Anterior Repositioning.

Aims: The present trial was carried out to assess the alterations in position of hyoid bone, sagittal and transverse plane dimensions, and oropharyngeal volume following the treatment in subjects with Class II skeletal malocclusion with edgewise technique using the functional appliances using the CBCT

Materials and Methods: 18 subjects were treated using the fixed appliances with Mandibular Anterior Repositioning. CBCT was recorded before placement and after removal of the fixed appliances. The CBCT was analyzed to evaluate ANB, SN-GoGn, AP position of hyoid bone as a linear measure, SNA, and SNB. The collected data were subjected to the statistical analysis and the results were formulated.

Results: In the Mandibular Anterior Repositioning group, no statistically significant difference was seen in ANB, SNA, SNB, SN-GoGn, transverse oropharyngeal airway dimensions, and oropharyngeal airway volume. A statistically significant difference was seen in the AP airway dimension (p-value <0.0001). Hyoid position and transverse airway dimensions had a statistically significant difference, p-values of <0.0001. ANB and SNA were decreased significantly in the experimental group compared to the control group with the p-values as 0.0002 and <0.0001 respectively.

Conclusion: The present study concludes that the orthodontic therapy using Mandibular Anterior Repositioning (MANDIBULAR ANTERIOR REPOSITIONING) results in the positive increase of airway dimensions, hyoid bone position anteroposteriorly, and airway volume in the oropharyngeal region.

Keywords: Airway volume, Airway dimensions, Class II malocclusion, functional appliances, Mandibular Anterior Repositioning.

Keynote: Immediate change in the airway volume and airway extension is observed following anterior positioning of the mandible using functional appliances. The appliance that causes anterior mandibular advancements is also given to avoid the collapse of the upper airway in subjects with obstructive sleep apnea.

Introduction

Mandibular retrognathia is a common feature encountered in the subjects having Class II malocclusion in comparison to prognathism of the maxilla which is found in relatively fewer subjects.[1] The treatment options available for Class II malocclusion in subjects with growing skeleton include distalization or extraction of teeth in the maxillary arch, orthognathic surgery after growth ceased, and/or functional appliances. However, distalization and extraction can lead to a deranged soft tissue profile.[2] The use of functional appliances has shown to be an effective treatment strategy that improves the profile and corrects the relative position of mandible compared to maxilla in subjects with Class II malocclusion. One such well-accepted appliance is Mandibular Anterior Repositioning.[3]

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One associated problem with this malocclusion is SDB (sleep disorder breathing). The SBD is seen in approximately 6% of adolescents having Class II malocclusion. SDB is associated with poor study results, daytime sleep, lack of concentration, hyperactivity, and/or attention deficit disorder compared to the normal counterparts.[4] SDB is associated with certain predisposing factors including allergies, tonsillar enlargements, obesity, asthma, mandibular retrohgnathia, and other abnormalities of the craniofacial regions. It has been established that the position of the mandible is associated with oropharyngeal airway volume and the base of the cranium. Retrognathia of the mandible is demonstrated to decrease oropharyngeal airway volume. This volume reduction can be attributed to posteriorly placed hyoid bone or tongue.[5]

The immediate change in the airway volume and airway extension is observed following anterior positioning of the mandible using functional appliances. The appliance that causes anterior mandibular advancements is also given to avoid the collapse of the upper airway in subjects with obstructive sleep apnea.[6] The long-term results of using such appliances in growing adults, for altering the position of the hyoid bone, airway dimensions, and oropharyngeal volume are controversial, which can be attributed to difficult assessment of altering variables on two-dimensional models.[7]

Hence, the present trial was carried out to assess the alterations in the position of the hyoid bone, sagittal and transverse plane dimensions, and oropharyngeal volume following the treatment in subjects with Class II skeletal malocclusion with edgewise technique using the functional appliances using the CBCT (Cone Beam Computed Tomography). CBCT was chosen to assess the changes as it is a three-dimensional technique with high accuracy.

Materials and methods

The present retrospective clinical trial was carried out to assess the alterations in the position of the hyoid bone, sagittal and transverse plane dimensions, and oropharyngeal volume following the treatment in subjects with Class II skeletal malocclusion with edgewise technique using the functional appliances using the CBCT. The study population consisted of 18 subjects with skeletal Class II malocclusion. The study subjects included both males and females within the age range of 11 years to 13 years with a mean age of 11.6±1.62 years. The study was carried out approved by the Ethical Review Committee of the institute.

All included 18 subjects were treated using the fixed appliances with Mandibular Anterior Repositioning. CBCT was recorded before placement and after removal of the fixed appliances in centric occlusion and neutral head position for all 18 subjects. The study controls were comprised of 67 subjects matching the treatment group, who had skeletal Class II malocclusion but were not given any treatment.

The subjects who had cervical vertebrae maturation stage value of ≥5 before the treatment were not included as the growth in such subjects was not complete. On assessing the CBCT, the subjects showing deviation from the neutral head position, centric position, or were noticed with swallowing while CBCT was recorded were also excluded from the study.

Concerning the analysis of the oropharyngeal airway, transverse and anteroposterior dimensions of the oropharyngeal airway were measured in the midsagittal plane. Two horizontal planes parallel to FH (Frankfort Horizontal) plane were used to define the oropharyngeal airway, the superior line was bordered by the line connecting the posterior pharynx wall to the posterior nasal spine and inferior AP airway dimension going through the epiglottis tip. The CBCT was analyzed to evaluate ANB, SN-GoGn, AP position of hyoid bone as a linear measure, SNA, and SNB. The collected data were subjected to the statistical analysis and the results were formulated.

Results

The present retrospective clinical trial was carried out to assess the alterations in the position of the hyoid bone, sagittal and transverse plane dimensions, and oropharyngeal volume following the treatment in subjects with Class II skeletal malocclusion with edgewise technique using the functional appliances using the CBCT. The study population consisted of 18 subjects with skeletal Class II malocclusion. The study subjects included both males and females within the age range of 11 years to 13 years with a mean age of 11.6±1.62 years. The experimental study group had 11 females and 7 males. The demographic characteristics of the study subjects are listed in Table 1.

Table 1: Parameter changes in experimental group subjects at two-time intervals

Parameter	Before treatment (n=18)	After treatment (n=18)	p-value
Mean age (years)	11.6±1.62	-	
Age Range (years)	11-13	-	
Sex			
Males	7	-	
Females	13	-	

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Airway Dimensions (A-P)	7.26±2.32	9.12±2.54	0.0281
Airway Volume (mm^3)	9079.94±3398.17	14617.29±5531.24	0.0010
Airway Dimensions (Transverse in mm)	20.98±4.23	26.01±4.31	0.0012
SNA	81.02±2.63	79.76±3.02	0.1908
SNB	74.83±3.03	75.04±2.98	0.8352
Hyoid Bone Position (A-P)	25.2±3.03	30.1±3.62	0.0001
SN- GoGn	31.66±4.98	32.4±5.37	0.6709
ANB	5.61±4.97	4.59±1.31	0.4057

The mean time duration for which the appliance was worn by the study subjects was 10.4 months and the meantime of the debonding from the removal of the appliance was found to be 16.6 months. The study parameters for the experimental group (where Mandibular Anterior Repositioning was used) at two-time intervals are described in Table 1. These counter values for control group subjects are described in Table 2.

Table 2: Parameters in control group subjects at different cervical vertebrae maturation stages

Parameter	Cervical Vertebrae Maturation Stage (CVMS)					
	1 (n=7)	2 (n=14)	3 (n=19)	4 (n=11)	5 (n=9)	6 (n=7)
Airway Dimensions (A-P)	8.68±2.36	8.62±2.69	7.55±2.42	8.15±1.97	8.07±2.16	6.47±1.82
Airway Volume (mm^3)	7888.6± 2363.55	7977.96± 3035.97	8708.8± 3128.3	9636.91± 3683.75	10605.96± 4565.68	11653.9± 1079.05
Airway Dimensions (Transverse in mm)	21.85±5.69	20.4±6.02	21.69±4.96	22.07±6.3	21.5±8.29	22.93±2.16
SNA	80.24±1.1	80.39±2.46	80.91±1.94	80.46±2.54	80.56±2.33	81.36±0.98
SNB	73.97±0.04	74.59±1.67	74.87±1.35	74.19±2.34	74.69±2.04	75.7±0.99
Hyoid Bone Position (A-P)	24.05±2.46	26.07±2.58	26.1±3.07	27.55±2.59	26.71±2.77	27.11±2.36
SN- GoGn	33.31±2.23	31.4±3.03	32.62±2.22	32.96±2.13	31.56±2.39	33.3±2.73
ANB	6.26±0.97	5.83±1.21	6.04±1.1	6.26±1.65	5.82±1.53	5.46±0.7

The changes in the two groups before treatment and after treatment are summarized in Table 3.

Table 3: Comparison of study parameters in control group ad experimental group at two different time intervals

Parameter	Control Group (n=67)	Experimental Group (n=18)	p-value
Airway Dimensions (A-P)	-1.1045±0.083774	1.837±2.52632	<0.0001
Airway Volume (mm^3)	2221.4771±1309.07939	5538.39±4848.72814	<0.0001
Airway Dimensions (Transverse in mm)	0.8062±1.03515	4.796±4.55567	<0.0001
SNA	0.5356±0.40871	-0.704±1.36707	<0.0001
SNB	0.8891±0.65753	0.2898±1.23667	0.0066
Hyoid Bone Position (A-P)	1.5039±1.50569	4.3019±2.68787	<0.0001
SN- GoGn	0.19±0.94	0.54±2.29	0.3255
ANB	-0.3645±0.3009	-1.01±1.25243	0.0002

The two groups were the control group where no treatment was given and the other experimental group where the fixed functional appliance Mandibular Anterior Repositioning was given to the 18 included subjects. Concerning the Mandibular Anterior Repositioning group, it was seen that at pre-treatment time interval there was no statistically significant difference in assessed parameters including ANB, SNA, SNB, SN-GoGn, transverse oropharyngeal airway dimensions, and oropharyngeal airway volume. However, a statistically significant difference was seen in the Antero-posterior airway dimension measured at the narrowest diameter. It was found that the AP airway dimension was significantly smaller in the group with Mandibular Anterior Repositioning compared to the control group where no treatment was given (p-value <0.0001).

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It was also found that hyoid position and transverse airway dimensions anteroposteriorly were found to have a statistically significant difference, where these parameters had statistically increased values in the experimental group compared to the control group with the p-values of <0.0001. Also, the values for ANB and SNA were decreased significantly in the experimental group compared to the control group with the p-values as 0.0002 and <0.0001 respectively. For the Mandibular Anterior Repositioning group, SNB also increased in the experimental group, however, the increase was not statistically significant (p-value=0.0066). The SN Go-Gn value did not show any statistically significant change in its value, with the p=0.3255.

Discussion

The present retrospective clinical trial was carried out to assess the alterations in the position of the hyoid bone, sagittal and transverse plane dimensions, and oropharyngeal volume following the treatment in subjects with Class II skeletal malocclusion with edgewise technique using the functional appliances using the CBCT. Mandibular Anterior Repositioning and similar appliances are used in orthodontics for treating the subjects with skeletal Class II malocclusion to reposition the mandible to the desired anteroposterior position. This placement of mandible anteriorly has also shown to increase airway volume and alter airway dimensions as shown in the present study. These findings were consistent with the findings of Iwasaki et al[8] in 2014 where authors found an increase in airway volume following the treatment in Class I malocclusion subjects using Herbst appliance in comparison to controls.

In the present trial, the values for ANB and SNA were decreased significantly in the experimental group compared to the control group with the p-values as 0.0002 and <0.0001 respectively. Concerning the Mandibular Anterior Repositioning group, it was seen that at pre-treatment time interval there was no statistically significant difference in assessed parameters including ANB, SNA, SNB, SN-GoGn, transverse oropharyngeal airway dimensions, and oropharyngeal airway volume. However, a statistically significant difference was seen in the Antero-posterior airway dimension measured at the narrowest diameter. It was found that the AP airway dimension was significantly smaller in the group with Mandibular Anterior Repositioning compared to the control group where no treatment was given (p-value <0.0001).

It was also found that hyoid position and transverse airway dimensions anteroposteriorly were found to have a statistically significant difference, where these parameters had statistically increased values in the experimental group compared to the control group with the p-values of <0.0001. Also, the values for ANB and SNA were decreased significantly in the experimental group compared to the control group with the p-values as 0.0002 and <0.0001 respectively. For the Mandibular Anterior Repositioning group, SNB also increased in the experimental group, however, the increase was not statistically significant (p-value=0.0066). The SN Go-Gn value did not show any statistically significant change in its value, with the p=0.3255. These results showed that an anteriorly placed mandible resulted in positive airway changes and hyoid bone positioning. These findings were similar to the findings by the studies of Li L et al[9] in 2014 and Ulusoy C et al[10] in 2014 where authors used Twin blocks and activators respectively.

The present study had a small sample size, however, the sample size power was analyzed and the results found that the minimum sample size required for the study came out to be 11. The effect of the Mandibular Anterior Repositioning treatment on males and females based on gender could not be determined. Previous studies in literature showed controversial results in terms of gender where Tan et al[11] in 2013 found a greater airway increase in the male gender compared to females. Another study by Abramson et al[12] in 2009 found no effect of gender on airway alterations following treatment with functional appliances. These results warrant further research.

Conclusion

The present study concludes that the orthodontic therapy using Mandibular Anterior Repositioning results in the positive increase of airway dimensions, hyoid bone position anteroposteriorly, and airway volume in the oropharyngeal region. The study had few limitations including small sample size, shorter monitoring period, and geographical area bias as the included subjects were from the same ecological niche. Hence, further future studies with larger sample size, longer monitoring period, and different ecological areas are required to reach a definitive conclusion.

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