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Original Article

THE INFLUENCE OF DENTAL ARCH DIMENSIONAL CHANGES ON PHARYNGEAL AIRWAY AFTER EXTRACTION TREATMENT IN CLASS II DIVISION 1 MALOCCLUSIONS

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Abstract:
Objectives: The aim of the study was to evaluate the influence of dental arch dimensional changes on pharyngeal airway after extraction treatment in non growing class II division 1 cases.
Materials and Methods: Pre and post treatment lateral cephalometric radiographs and study casts of twenty eight adult female patients of mean age 21 +/-3 years with class II division 1malocclsions whom underwent fixed orthodontic treatment with extraction of four first premolars were included in this study. Pre and posttreatment lateral cephalograms were digitally analyzed to assess the changes in the upper and lower pharyngeal airway space. The arch perimeter and depth were measured on the pre and posttreatment scanned study models. Descriptive statistics were used to analyze the readings. Student’s paired t-test was done to compare the pre and posttreatment mean values of the measurements.
Results: Statistical analysis revealed an insignificant increase in the upper airway and insignificant decrease in the lower airway between pre and post treatment cephalometric measurements. On the other hand, a highly significant decrease was found in the maxillary and mandibular arch perimeter, it also showed a significant decrease in the maxillary and mandibular arch depth between pre and posttreatment values.
Conclusion: The reduction in the arch perimeter and depth parameters did not impair the pharyngeal air way space at non growing class II division 1 cases after orthodontic treatment that entailed extraction of four first premolars with retraction of anteriors.
Keywords: Air way, Dental arch, Class II, Extraction.

Introduction:

The upper airway has usually been an area of interest in orthodontic literature because the nasopharyngeal and oropharyngeal structures have important roles in the growth and development of the orodental and craniofacial complex.[1]Since upper airway obstruction may influence the development of dentofacial structures of growing patients by altering the breathing pattern.[2]

Correlation between different malocclusions and airway dimensions has been explored to estimate the relationship between the dentofacial complex development and oropharyngeal and nasopharyngeal structures.[3] Angle classification did not consider any correlation between ANB angle and oropharynx volume.[4] A previous study reported that oropharyngeal volume is correlated positively with SNB.[5] Another study[6] revealed that oropharyngeal volume has a positive correlation with the third cervical vertebra, hyoid bone distance, mandibular length, and the cranial base angle. These studies demonstrated that Class II patients' airway volume had been significantly reduced than patients with Class I and Class III malocclusion.[5] Class II malocclusion cases may have narrow airways, where they are associated with retrognathic mandible.[7]Retrognathic mandibles cases are accompanied by posterior positioning of hyoid bone which could also influence the airway dimensions.[8] Pharyngeal airway changes following orthodontic treatment occur mainly as a result of the retraction of anterior teeth, which changes the arch dimension and in turn influence the tongue position.[9]The pharyngeal airway space dimensions and function is affected by these positional changes in the oral cavity, thus affecting breathing.[10] Some studies [8, 11] have reported the effect of orthodontic treatment with extractions on the hyoid bone and tongue position which may alter the anatomy of the upper airway. A previous study[12] have demonstrated that extraction treatment with maximum anchorage may causes retraction of tongue position and upper airway narrowing. However, other studies[13, 14] have shown that oropharyngeal dimensions have not been affected by extractions.

Dental arch dimensional changes attributed to orthodontic treatment are essential for the orthodontist. Such that the understanding of these changes is important in treatment plan and retention.[15]The change in arch dimensions may be affected by Angle classification and various modalities of treatment. Description of the exact arch change, varies in different Studies.[16, 17]

There are different modalities used for evaluation of airway as computed tomography, cephalometric analysis, magnetic resonance imaging and cone-beam computed tomography [18] .In orthodontics, evaluation of the upper airway changes is usually done using lateral cephalograms.[9]Despite of the limited data obtained by cephalogram compared to cone-beam computed tomography, it is recommended as the latter is not a part of usual examination and exposes patient to more radiation.[9] Cephalometric measurements of the pharyngeal air way have been proven to be a reliable tool of diagnosis for assessment of pharyngeal space, although they are two dimensional.[19]

This retrospective study aimed to evaluate the influence of dental arch dimensional changes on pharyngeal airway in Class II division 1 adult cases following orthodontic treatment consisting of four premolars extraction.

Materials and Methods:

This retrospective study was applied on digital lateral cephalometric radiographs and study casts which were taken pre and post orthodontic treatment. Based on data from a previous study [20], sample size calculation estimated twenty eight patients which had a statistical power of 80% with 95% confidence level and significance level of 5% which was set up to evaluate whether the pre and posttreatment pharyngeal air way dimensions showed significant differences. The data were collected from previously treated patients' files in outpatient orthodontic clinic at Faculty of Oral &Dental Medicine, Fayoum University where the study was ethically approved .Cases were selected according to the following inclusion criteria:

- Mild to moderate skeletal Class II division1 malocclusion with ANB = (5-7°) and overjet = (6-8 mm).
- Adult females with mean age 21 +/-3 years.
- No congenitally missing teeth with the exception of the third molars.
- Free medical history of obstructive sleep apnea, nasal obstruction, craniofacial deformities or pharyngeal pathologies.
- Neither palatal expansion nor functional appliances were used and no surgeries were performed.
- Treated with fixed preadjusted orthodontic appliance (0.022 x 0.028 inch bracket slot) and anchorage was reinforced using transpalatal arch in the maxillary arch and lingual arch in the mandibular arch.
- Four first premolars were extracted followed by anterior teeth retraction and space closure using sliding mechanics.

Analysis of cephalometric radiographs were done using Dolphin Imaging Software. The cephalometric landmarks and linear measurements used in this study to assess the changes in pharyngeal airway dimensions were based on (McNamara's airway analysis)[21].The variables assessed were upper central to Frankfort plane angle (U1-FH), incisor mandibular plane angle (IMPA), upper and lower airway dimensions, where the upper pharyngeal airway width measured from the dorsum of the soft palate to the closest point on the posterior pharyngeal wall and the lower pharyngeal airway width was the distance measured between the posterior pharyngeal wall and the intersection between the posterior tongue contour and angle of the mandible Fig (1).

All of the collected maxillary and mandibular study casts were digitally scanned using three dimensional digital scanner (SHINING 3D -EX Pro). Arch landmarks and measurements were recorded by Dolphin imaging software program. The measured arch dimensions were arch perimeter and depth. Dental arch was divided into four segments (two per quadrant) extending from the mesiobuccal cusp tip of first molars to the cusp tip of canines, and from the cusp tip of canines to the mesial contact point of the central incisors, then arch perimeter was calculated by summing these four segments. Arch depth was determined by measuring the length of a perpendicular line constructed from the mesial contact point of the central incisors to intermolar plane which connects the mesiobuccal cusp tip of the first molars Fig (2). All measurements were carried out by a single blinded researcher. They were reassessed by the same examiner for intraexaminer reliability test.

Results:

Statistical analysis was undergone using IBM Statistical Package for Social Science (SPSS) software. The mean and standard deviation values for each variable were determined with descriptive statistics. The pretreatment versus posttreatment values were analyzed using paired t- test. Significance level was set at probability less than 5 % ($P \leq 0.05$). Intra class correlation coefficient value indicated a good reliability (ICC=0.9).

Statistical analysis revealed highly significant decrease in (U1-FH) and (IMPA) posttreatment ($P \leq 0.001$), whereas an insignificant increase was observed in the upper airway and insignificant decrease was found in the lower airway between pre and posttreatment cephalometric measurements ($P > 0.05$) as shown in table (1).

Statistical analysis revealed highly significant decrease in maxillary and mandibular arch perimeter after treatment ($P \leq 0.001$), it also showed very significant decrease in maxillary arch depth ($P \leq 0.01$) and a significant decrease ($P \leq 0.05$) in mandibular arch depth between pre and post treatment values as shown in table (2).

Discussion:

It is important when planning an orthodontic treatment to take into consideration the pharyngeal airway space and respiratory form such that the nasopharyngeal airway size could be altered by orthodontic therapy. The present study concerned with evaluating the effect of arch dimensional changes on pharyngeal airway in non growing Class II division1cases which had undergone orthodontic treatment involving the extraction of four first premolars to provide sufficient space for alignment with retraction of anteriors, as the change in the incisors position and dental arch parameters could alter the position of the tongue and thus affecting the pharyngeal airway dimension. In the present study, the assessment of dentoskeletal changes posttreatment showed highly significant decrease in U1-FH and IMPA ($P \leq 0.001$). Regarding the pharyngeal air way changes after treatment, non significant difference was observed in the upper and lower airway after treatment ($P > 0.05$). The minimal anchorage used and the mesial movement of molars may contributed to these findings. The results of the present study were in accordance with Valiathan et al.[8], who noticed a nonsignificant increase in the oropharyngeal air way volume and area of maximum constriction after orthodontic treatment in extraction subjects. Also the findings of a previous study[20] were in agreement with these of that study, where there was no significant difference between the pre and post treatment upper and oropharyngeal airway area in extraction cases of class II division 1 with bimaxillary protrusion. Whereas Germec-Cakan et al.[12] reported an increase in superior and middle airway size at subjects treated by extraction with minimum anchorage. An increase at posterior tongue space post mesial molar movement or continuing pharyngeal growth might be a possible explanation for this. While subjects treated by extraction with maximum anchorage, the size of middle and inferior airway decreased. This could be due to the reduction of tongue space following incisor retraction and this narrowing cannot be explained by pharyngeal growth changes. Dental arch dimensional changes evaluation post treatment in this present study showed a significant decrease in both maxillary and mandibular arch perimeter and depth. This reduction in arch depth was in agreement with Ho and kerr [22]who noticed significant decrease in vertical molar dimension post extraction treatment because of the loss of one dental unit on each quadrant of the dental arch and also due to the changes in the incisors inclination.

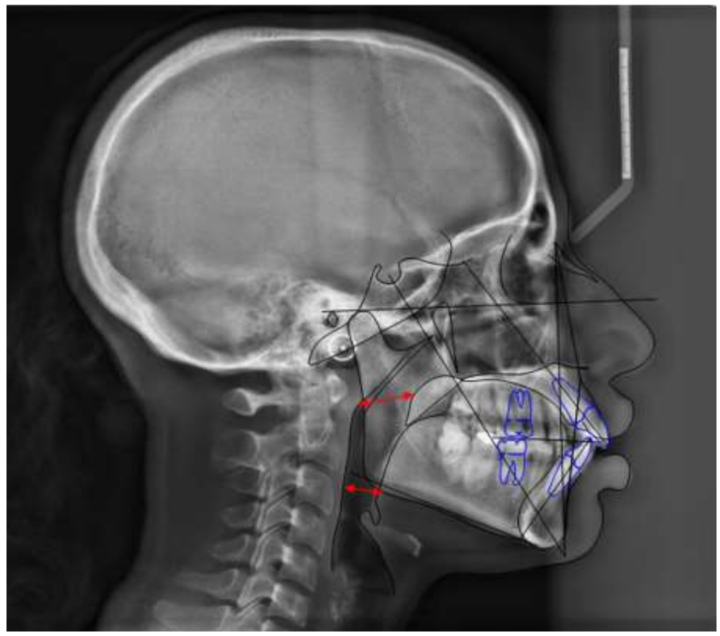

Fig (1): Cephalometric analysis of upper and lower pharyngeal airway

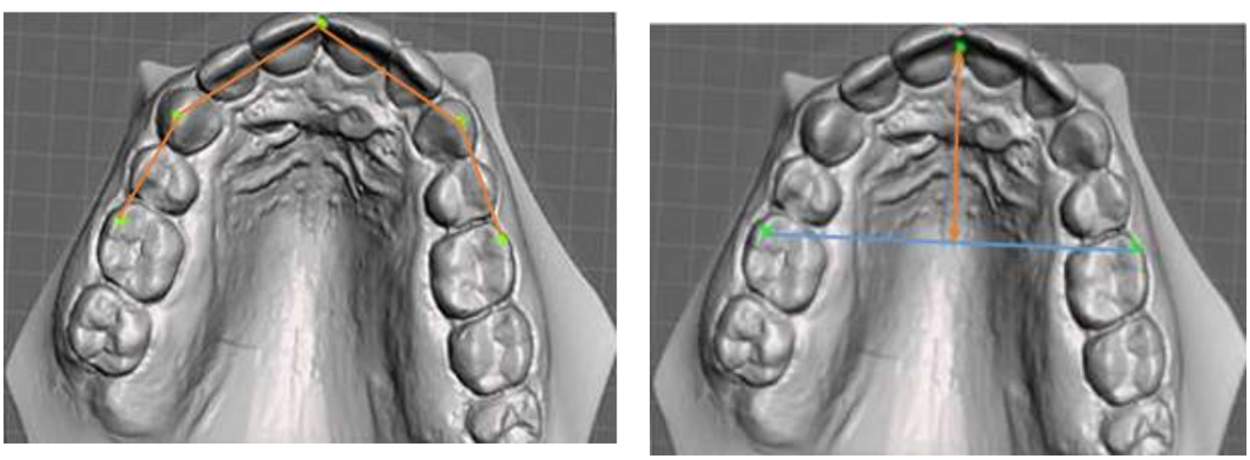

Fig (2): Cast analysis: (a) Arch perimeter (Left) (b) Arch depth (Right)

Table (1) Comparison between pre and posttreatment cephalometric variables:

Cephalometric Parameter	Pretreatment (Mean +/-SD)	Posttreatment (Mean +/-SD)	Mean difference	P value
U1-FH	122.3 +/- 2.7	110.8 +/- 2.4	-11.5	0.0001***
IMPA	103.1 +/- 3.2	95.5 +/- 3.1	-7.6	0.001 **
Upper airway	11.9 +/- 3.2	13.7 +/- 3.5	1.8	0.374 NS
Lower airway	9.1 +/- 1.3	8.4 +/- 1.2	-0.7	0.355 NS

SD: standard deviation, **NS:** not significant**, * P** $\leq$ 0.05, **** P** $\leq$ 0.01, ***** P** $\leq$ 0.001

Table (2) Comparison between pre and posttreatment arch dimensional variables:

Arch	Variable	Pretreatment (Mean +/-SD)	Posttreatment (Mean +/-SD)	Mean difference	P value
Maxillary	Arch perimeter	75.8 +/- 3.5	67.4 +/- 3.2	-8.4	0.001***
	Arch depth	28.6 +/- 2.9	22.6 +/- 2.7	-6	0.004**
Mandibular	Arch perimeter	65.6 +/- 3.2	57.4 +/- 3.5	-8.2	0.001***
	Arch depth	21.6 +/- 2.5	18.3 +/- 2.2	-3.3	0.03*

SD: standard deviation, **NS:** not significant,*** P** $\leq$ 0.05, **** P** $\leq$ 0.01, ***** P** $\leq$ 0.001

The results of the present study agreed with the findings of Stefanovic et al.[11], who found that the reduction at dental arch perimeter as a result of premolars extraction did not negatively affect the pharyngeal airway dimensions.

The results of the present study were in contrary with the findings of Chen et al.[23] who reported that large retraction of incisors at adult patients with bimaxillary protrusion could lead to narrowing in the dimensions of the upper airway. In a systematic review Hu et al[14] demonstrated that large retraction of anterior teeth following all first premolar extractions might cause narrowing of upper airways.

The results of the present study revealed that the significant reduction in dental arch perimeter and depth following extraction of four first premolars with retraction of anteriors did not negatively affect the upper and lower pharyngeal air way space in class II division 1adult cases.

Conclusion:

The orthodontic treatment that entailed extraction of four first premolars with retraction of anteriors at class II division 1adult cases did not impair neither the upper nor the lower pharyngeal air way space despite of the reduction in the arch perimeter and depth.

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