ORIGINAL RESEARCH

Upper Airway Post-planned Positioning of Maxillary Anterior Teeth: An Acoustic Pharyngometric Study

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Abstract

Introduction: The effect of the retraction of anterior teeth on the upper airway as a response to orthodontic tooth movement is a less explored area in orthodontic literature, which requires deliberation in order to avoid undesired effects. The present study evaluates the change in upper airway dimensions post-intrusion and retraction of maxillary anterior teeth using Acoustic Pharyngometry, a noninvasive, chair-side diagnostic modality.

Materials and methods: The upper airway dimensions (mean area and volume) changes were assessed during pretreatment and 3 months post-intrusion and retraction of anterior teeth in a sample of 30 patients by using Eccovision(R) Acoustic Pharyngometer (Sleep Group Solutions, Florida, USA), a noninvasive diagnostic modality.

Result: A reduction in mean area (0.11 cm^2) and volume (1.15 cc) of upper airway was observed following intrusion and retraction of maxillary anterior teeth, although the results obtained were not statistically significant ($p > 0.05$).

Conclusion: As the results of this study suggest, there is reduction in mean area and volume of upper airway following intrusion and retraction of maxillary anteriors; it is essential to assess the pretreatment dimensions of upper airway. Nonionizing and noninvasive modalities like acoustic pharyngometry can be utilized as an efficient and convenient diagnostic modality to assess the upper airway in orthodontic clinics.

Keywords: Acoustic pharyngometry, Intrusion and retraction, Upper airway.

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Introduction

Malocclusions are being studied in all three planes of space: transverse, sagittal, and vertical. However, according to various population-based surveys, it is evident that majority of the malocclusion is observed in sagittal plane.[1] A large number of patients reported to orthodontic clinics for correction of bimaxillary protrusion and for correction of increased overjet and overbite. The treatment plan for such cases usually includes extraction of first premolars and intrusion and retraction of anterior teeth in the space available. Hence, a great amount modeling and remodeling of dentoalveolar housing is expected.[1,2]

Such tooth movements may also compromise the upper airway dimensions and make the individual susceptible to upper airway sleep disorders. It is advisable that the principle of "do no harm" should be an integral part of any treatment modality. Thus, maintenance/improvement of effective oral function should be considered while planning any orthodontic treatment. The available literature shows results suggestive of changes in airway dimensions following retraction of anterior teeth.[3–5] The literature also yields studies contemplating the variation observed in airway dimensions in different malocclusions and facial types.[6,7] The decision-making process of present day orthodontics also concentrate toward "Airway-focused Orthodontics" in order to achieve structural harmony and functional efficacy.[8] Therefore, it is essential to evaluate the pretreatment upper airway dimensions and it is advisable to avoid compromising the same posttreatment.

The various diagnostic modalities to assess airway include cephalometry, computed tomography (CT), cone-beam computed tomography (CBCT), magnetic resonance imaging, acoustic pharyngometry, rhinomanometry, endoscopy, etc.[9] Among these diagnostic modalities for evaluating the upper airway dimensions, more commonly used in orthodontics are clinical examination, cephalometry, and CBCT. However, the efficiency of these commonly used modalities including CBCT is questionable[10] as they record the dynamic airway in a static stage and may lead to incorrect assessment of airway parameters. Acoustic pharyngometery (AP) is a noninvasive diagnostic modality which can precisely map the size and structure of upper airway. This modality being noninvasive, user, and patient friendly, can be readily used for accurately assessing the dimensions of the dynamic upper airway.[11,12]

The orthodontic diagnosis and treatment planning includes the planned incisor position (PIP), which implies to planning the position of maxillary and mandibular incisor followed by positioning of remaining posterior teeth. Therefore, it is essential to understand the influence of this post-treatment position of incisors and its influence on remaining oro-facial structure and their function. Since, the evidence demonstrating the consequence of intrusion and retraction of anterior teeth on the upper airway is controversial,

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more deliberation and evaluation of the topic is required. Hence, the present study was designed with the aim to evaluate the change in upper airway dimensions, post-intrusion, and retraction of maxillary anterior teeth using AP.

Materials and Methods

The present study is a prospective observational study with a convenient sample of 30 subjects (16 males and 14 females), carried out at a tertiary care government hospital using STROBE guidelines for conduct of cross-sectional observational studies. Necessary clearance was obtained from the institutional review committee (approval number-IEC/OCT/2018 dated October 22, 2018) and informed consent was obtained from participants of the study. The following inclusion and exclusion criteria were considered for selection of subjects for the study:

Inclusion Criteria

Adult subjects diagnosed as mild Class II/Class I bimaxillary dentoalveolar protrusion with increased proclination of the maxillary incisors [maxillary incisor to Nasion-Point A (1-NA) angular value of 22° to ≤40°; linear value of >4 mm], ANB angle of 2° to ≤7°, mild crowding ≤3 mm, overbite of 1 mm to ≤4 mm associated with horizontal to average growth pattern and treatment plan warranting therapeutic extraction of first maxillary premolar bilaterally with intrusion and retraction mechanics for maxillary anterior teeth with Group A anchorage requirement.

Exclusion Criteria

History of orthodontic treatment or any periodontal surgery and bone grafting in the maxillary anterior dentoalveolar segment; history of systemic diseases influencing bone metabolism and any other syndromic conditions such as cleft lip and palate.

Standard orthodontic pretreatment records and AP (T0) were obtained for all subjects. The AP was recorded using the Eccovision(R) Acoustic Pharyngometer (Sleep Group Solutions, Florida, USA) as per manufacturer instructions. A graph called "pharyngogram" was generated for each patient, which depicts the upper airway area and volume (Fig. 1). A standardized treatment protocol was followed for all the subjects. After anchorage preparation using Nance palatal button, all subjects were bonded with 0.018 inch MBT PEA. The standardized sequence of arch wire was followed for all subjects starting with 0.016 inch NiTi, 0.016 inch × 0.022 inch NiTi to 0.016 inch × 0.022 inch SS arch wire to achieve levelling and alignment. After levelling and alignment, individual canine retraction was carried with reinforced anchorage in the form of consolidated maxillary second molar to maxillary second premolar using 0.010 inch SS ligature wire in a figure of 8 configuration. The individual canine retraction was carried out using closed coiled NiTi springs of 12 mm length.

On completion of individual canine retraction, maxillary second molar, maxillary first molar, maxillary second premolar and maxillary canine were consolidated into a single unit using 0.010 inch SS ligature wire placed under the arch wire in figure of 8 configuration. Similarly, four maxillary incisors were also consolidated into a single unit. Following this, intrusion and retraction of maxillary incisors was accomplished using asymmetric T Loop[13] fabricated using 0.016 inch × 0.022 inch titanium molybdenum alloy (TMA) wire.

A second set of orthodontic records including AP (T1) after 3 months of achieving the desired space closure by retraction and intrusion of maxillary anterior teeth was obtained.

The data collected at T0 and T1 were compiled in Microsoft Excel sheets [version Excel 2010 (Windows), Microsoft Corporation One, Microsoft Way, Redmond, Washington, USA] and Statistical Package for Social Sciences (SPSS version 21.0. Armonk, New York, USA: IBM Corp.) for Microsoft Windows was used to statistically analyze the complete data. The continuous variable data were presented as mean and standard deviation (SD) with paired *t* test used to carry out the intragroup statistical comparison. The *p*-values less than 0.05 were considered to be statistically significant for the present study.

Results

The study sample consisted of 30 subjects (16 males and 14 females) with mean age of 18.1 ± 2.5 years. Twenty two subjects did not exhibit any crowding, six subjects exhibited 2 mm crowding while two subject had 1 mm of crowding, with mean proclination of maxillary incisors as 34.1 ± 3.5°. Ten subjects showed ANB angle of 2°, 14 had ANB of 3°, while six subjects showed ANB of 4°. Eighteen subjects had an average growth pattern while 12 had horizontal growth pattern.

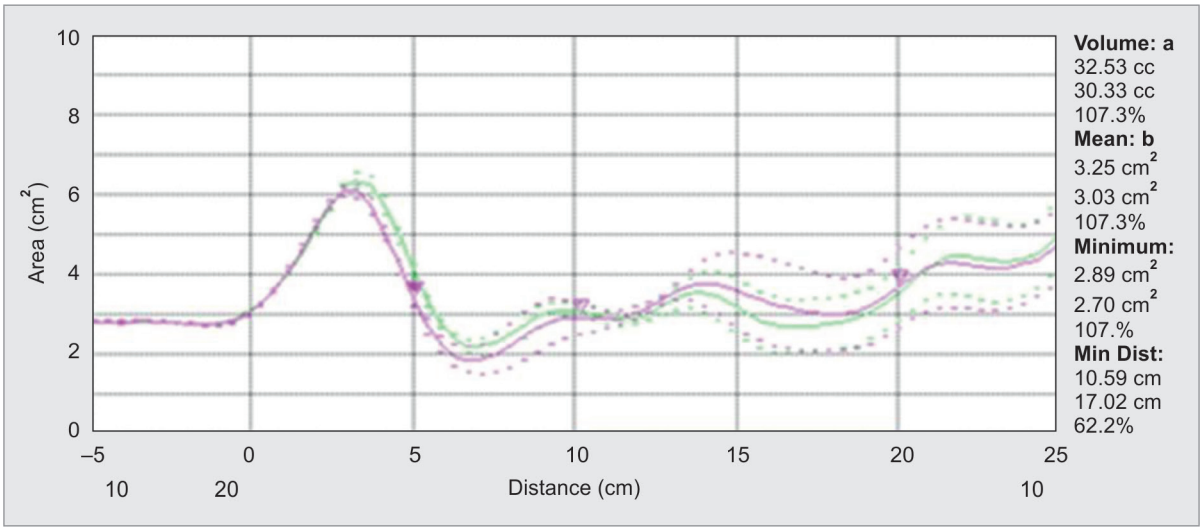

Fig. 1: Pharyngogram. (A) Upper airway volume; (B) Upper airway mean area T0—Purple line and T1—Green line

The mean area and volume of upper airway recorded at T0 were 3.22 cm^2 and 32.36 cc, respectively. There was a change in the mean area and volume of upper airway recorded at T1, i.e., 3.11 cm^2 and 31.21 cc, respectively. A reduction of 0.11 cm^2 in mean area and that of 1.15 cc in volume of upper airway was observed following intrusion and retraction of maxillary anterior teeth. However, this reduction was not statistically significant ($p > 0.05$) (Table 1, Figs 2 and 3).

Discussion

The study of effect of orthodontic tooth movement/orthopedic correction/ortho-surgical treatment on upper airway is a new dimension in the orthodontics. Several studies have been listed in literature to study the changes in dimensions of upper airway following ortho-surgical corrections and orthopedic corrections. The literature scan also shows that even though there may be reduction in upper airway volume associated with retraction of teeth, there is limited evidence to substantiate that these effects are detrimental for upper airway. Hence, a need for better study was expressed to confirm the effect of retraction of teeth on upper airway area and volume.[14,15] The various modalities used in literature to evaluate the upper airway include two dimensional (2D) lateral cephalogram, or three dimensional (3D) CT and CBCT. The main disadvantage of the 2D modalities is that it records the upper airway which is dynamic structure, in a static form, thus chances of inaccurate assessment could not be ruled out. Even though the 3D modalities like CBCT and CT have been proved to provide accurate dimensional readings of upper airway, these modalities use X-ray radiation, which has been proven to cause cumulative detrimental effect to the body tissues. Therefore, a need was felt to use a diagnostic modality which can record the upper airway in its dynamic state without any harmful effect on adjoining body structure.

AP is a noninvasive diagnostic modality that yields a three-dimensional assessment of upper airway. It works on the principles of physics of sound waves. Once the sound waves are generated, they travel through the upper airway and get reflected from the structures of upper airway and are received by the second microphone; to generate a graphical representation (Pharyngogram) which illustrates the upper airway volume and area (Fig. 1). The pharyngogram on x-axis depicts the distance in cms from lips to various structural compartments of upper airway (such as the oral cavity, oropharynx, till epiglottis) and on y-axis the area of respective structural compartment in cm^2. The system also calibrates the mean volume, mean area, and minimum area of the complete upper airway and the minimum distance till epiglottis in a particular patient, thus generating various dimensions of upper airway in dynamic state. AP has been proved to be an effective, reliable, and noninvasive diagnostic modality to determine and monitor upper airway changes during or after treatment.[11,16–18] Hence, this modality was used to assess upper airway volume and mean area in the present study. On comparing with other 2D and 3D diagnostic modalities, AP has been proved to be better than 2D modalities and equivalent to 3D modalities in assessing the upper airway dimensions. Moreover, since there is no radiation exposure or any other invasive procedure, AP is a patient and user-friendly diagnostic modality.[11,16–20]

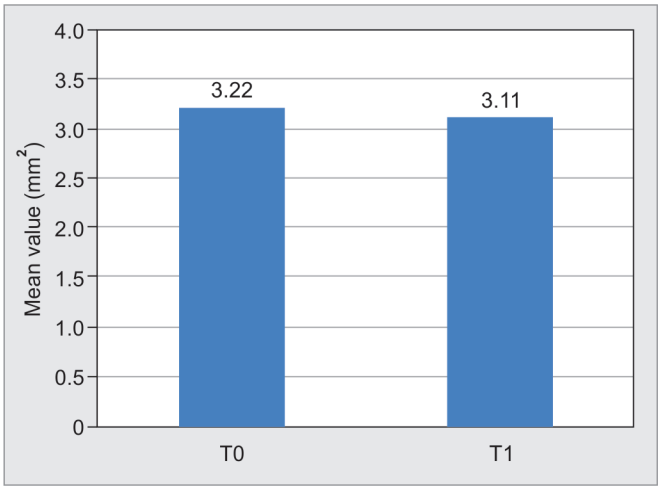

Fig. 2: Upper airway mean area at T0 and T1

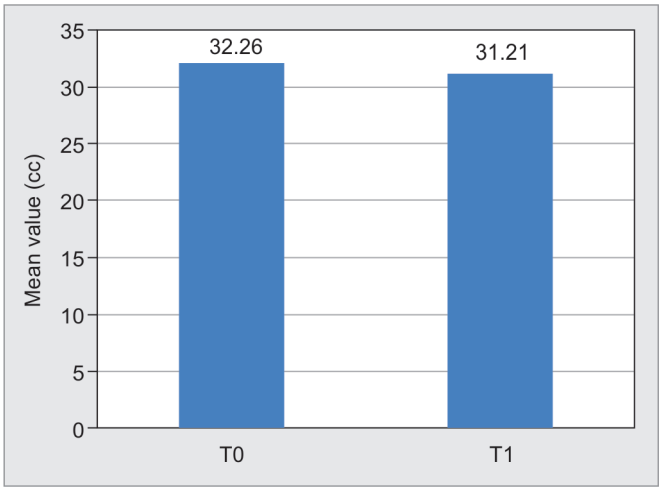

Fig. 3: Upper airway mean volume at T0 and T1

Assessment of changes in upper airway dimensions following OTM is desirable so that clinicians do not end up in detrimental effect on a vital function of stomatognathic system, that is, respiration. Literature reveals various studies[14,15,21,22] have determined the effect of retraction of anterior teeth on upper airway using lateral cephalogram and CBCT. The present study used AP as a modality to measure the airway dimensions and it was noted that there is a reduction in upper airway area and volume following intrusion and retraction of anterior teeth by 1.05 cc in upper airway volume and 0.11 cm^2 in upper airway area. However, the results were statistically nonsignificant (Table 1 and Figs 2 and 3). The previously conducted studies and systematic reviews found that varying results were

Table 1: Change in upper airway volume (cc) and mean area (cm^2) from T(0) to T(1)

	Pretreatment (T0) (n = 30)		*Post-retraction and intrusion (T1) (n = 30)*		*Change (T1–T0)*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*p value*
Mean upper airway volume	32.26	5.31	31.21	5.34	–1.05	0.071^{NS}
Mean upper airway area	3.22	0.54	3.11	0.51	–0.11	0.153^{NS}

p value by paired *t* test. $p < 0.05$ was considered to be statistically significant; NS, not significant

seen in studies that had used 2D diagnostic modalities for assessing the airway changes, whereas in the studies using 3D diagnostic modalities, a significant reduction in airway dimensions was observed, following retraction of anterior teeth.[21] The previously conducted studies also established significant correlation between amount of incisor retraction and airway changes in terms of reduction in hyoid distance and reduction in cross-sectional area of hypopharyngeal region.[21,22] However, evidence which would substantiate compromised airway following OTM was not found.[14,15]

Clinical Significance

The decision of PIP along with its influence on oro-facial structures and their functions is crucially important for stable treatment outcome. The present study attempts to highlight the changes in the upper airway following intrusion and retraction of maxillary anterior teeth. Even though the clinical significance of results of present study with respect to patient with otherwise normal airway may be very low, the reduction in the upper airway dimensions observed is suggestive of need to assess airway parameters before considering retraction of anterior teeth, especially in patients requiring maximum retraction (bimaxillary protrusion) and those with compromised airway. In patients with compromised upper airway, retraction of anterior teeth may lead to further reduction in dimensions thereby aggrieving the airway. Therefore, it is recommended to exercise caution and meticulous treatment planning, while considering PIP especially for patients requiring maximum retraction and intrusion of maxillary anterior teeth with compromised upper airway so as to obtain a favorable result without any iatrogenic effects.

Limitations and Recommendations

The present study does not take into account factors such as role of tongue size, tongue position, hyoid position, extent of retraction of mandibular incisor with its interrelation with tongue posture, etc., while considering the airway changes. Convenient sampling technique and small sample size add to the biases in the study. Therefore, long-term studies with higher level of evidence and larger sample size that will aim at determining the changes in airway with multifactorial interactions are recommended to obtain clear evidence on the subject.

Conclusion

A reduction in mean area and volume of upper airway post-intrusion and retraction of maxillary anterior teeth was observed in present study. Even though the statistically insignificant results were obtained, it is essential to ascertain the dimensions of upper airway prior to considering intrusion and retraction of anterior teeth for which AP can be an efficient and convenient diagnostic modality. However, long-term studies with larger sample size are recommended in order to obtain more realistic and reliable results.

Declarations

Ethics approval: Obtained from Institutional Ethical Committee.
Consent to participate: Not applicable.
Consent for publication: Not applicable.
Availability of data and supporting materials: Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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