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Case Report

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Acoustic pharyngometry: new vista in diagnosing the airway

Abstract

The objective of this article is to highlight the importance and use of Acoustic Pharyngometry as a 'Screening and Monitoring Tool' of compromised airway in all patients seeking treatment especially for orthodontics and Sleep Disordered Breathing (SDB). The article discusses two cases screened for compromised airway using this tool and treated using available orthodontic treatment options and appliances. Case one is of a 15yr old female patient diagnosed as a case of Mandibular hypoplasia secondary to unilateral TM joint ankylosis (right side) with a decreased airway and was planned for mandibular advancement of 7mm by Distraction Osteogenesis. Acoustic pharyngometry carried out in VTO showed improvement in the decreased airway parameters. The same treatment objective was accomplished after completion of pre surgical and post surgical orthodontics. Case two is of a 14yr old male patient diagnosed as a skeletal class II malocclusion with retroclined maxillary incisors and a locked mandible, planned for orthodontic camouflage along with a fixed functional appliance (FORSUS FRD). VTO showed improvement in the decreased airway parameters with Acoustic Pharyngometry and treatment objectives were accomplished orthodontically. Both cases showed marked improvement in all airway parameters as predicted at the diagnostic stage. The changes achieved post treatment corroborated with the pretreatment plan as planned. Orthodontic treatment is aimed at improving the general health and esthetics of our patient's Acoustic pharyngometry is a valuable tool in for screening of the airway in three dimensions for all patients.

Keywords: airway, diagnosis, acoustic pharyngometry, sleeps disordered breathing (SDB)

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Introduction

Airway is the fourth dimension after the transverse, sagittal and vertical dimension which needs to be carefully addressed during the clinical and radiological assessment for any orthodontic patient. Angell[1] and Derichsweiler[2] in 1860 described maxillary expansion and its positive effects on nasal permeability. The relationship between respiratory function and craniofacial morphology has been debated for more than a century and it has been proved that airway obstruction; either nasal or oral does effect the normal growth and development of the craniofacial complex and if not treated in time leads to compensated growth and development of the patient.[3] The upper airway includes the nasal air passages, nasopharynx, oral cavity, oropharynx and the laryngopharynx. In the context of orthodontics, mandibular hypoplasia or a retro-positioned mandible/maxilla may be one of the contributory causes of airway constriction thereby leading to secondary OSA syndrome[4–6] other than partial obstruction of the nasal / upper airway. The aim of orthodontic therapy is to ensure positive changes in the quality of life of the patient in a holistic manner. Diagnosis and treatment planning of orthodontic cases should encompass the ardent assessment of airway as our planned treatment is likely to affect it either in a positive or a negative way. Polysomnogramphy[7] (PSG) is considered the gold standard test for diagnosis of compromised airway. Dynamic MRI and CT scans are useful imaging aids but not cost effective and with high radiation dose. Acoustic Pharyngometry (AP) is a relatively new modality for assessment of the airway in three dimensions which can be accurately used to screen the airway three dimensionally and also predict the corresponding effect of mandibular advancement on the upper airway.[8] This procedure can be done in an orthodontic clinic. This manuscript highlights the importance of acoustic pharyngometry in the screening of compromised airway in routine orthodontic patients and also monitors changes before and after institution of orthodontic treatment.

Material & methods

Two cases screened using this test and treated using orthodontic treatment options and appliances are discussed:

Case 1

A 15yr old female patient reported to the Dept of Orthodontics and Dentofacial Orthopedics with the chief complaint of asymmetry of her face and forwardly placed upper front teeth. Medical history revealed that the patient was an operated case of unilateral TM joint ankylosis of the right side at the age of 13yrs. On eliciting her history, her parents gave a positive h/o snoring at night since the last 8 yrs. Extra oral examination of the face (Figure 1) showed that the patient had a asymmetrical face with the chin deviating to the right side, a markedly convex profile with decreased facial proportions in the vertical fifths, reduced chin throat angle due to a retro positioned mandible. Intraorally (Figure 1) the patient was in permanent dentition with 28 permanent teeth present with all four third molars unerupted. Tongue was normal in size but was positioned at a lower level and airway grading was a Modified Mallampati Score III. The patient was subjected to routine investigations of lateral cephalogram,

Orthopantomogram (OPG), photographs, models and Acoustic Pharyngometry. Lateral cephalogram (Figure 1) showed that the patient had an ANB of 5º, Wits of +7, Jarabak Index (JI) of 65%, maxillomandibular differential of 11mm, a superior airway space (SAS) of 7mm as compared to norm of 9-11mm and posterior airway space(PAS) of 6mm as compared to norms of 9-11mm. Acoustic pharyngometry revealed a Mean Pharyngeal Area (MPA) of 2.37cm^2 against the norms of ≥2.8cm^2, Minimum Pharyngeal Area (MIPA) was 1.88 cm^2 and Pharyngeal Airway volume (PAV) was 23.70cm^3. The case was diagnosed as a case of Mandibular hypoplasia secondary to unilateral TM joint ankylosis (right side) with a decreased airway. Acoustic pharyngometry test was done with the mandible in VTO, showing improvement in the decreased airway parameters. The patient was planned for mandibular advancement of 7mm by Distraction Osteogenesis. The same was accomplished after completion of pre surgical orthodontics.

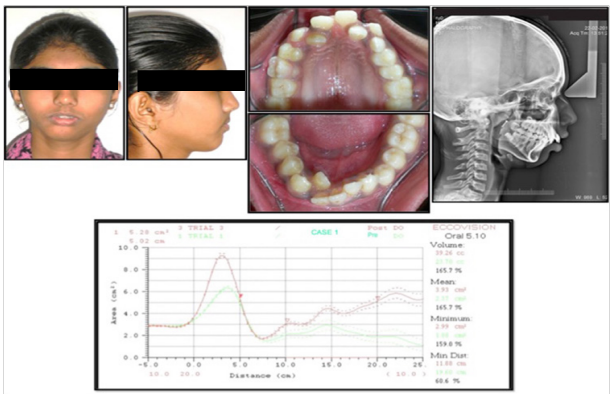

Figure 1 Pre treatment extraoral, intraoral, lateral cephalogram and pharyngogram- pre and post treatment trials.

Case 2

A 14yr old male patient reported to the Dept of Orthodontics and Dentofacial Orthopedics with the chief complaint of forwardly placed upper front teeth. Extra oral examination of the face (Figure 2) showed that the patient had a bilaterally symmetrical face, convex profile with decreased facial proportions in the vertical fifths. Intraorally (Figure 2) the patient was in permanent dentition with 28 permanent teeth present with mandibular third molars unerupted and missing maxillary third molars. Tongue was normal in size but was positioned at a lower level and airway grading was a Modified Mallampati Score II. The patient was subjected to routine investigations of lateral cephalogram; OPG, photographs and models were made. Cephalometric analysis of the lateral cephalogram (Figure 2) revealed that the patient was a skeletal class II with ANB of 9º, Wits of +12, Maxiollomandibular differential of 15mm with a hypoplastic mandible indicated by a decreased ratio of ANS-PNS to GoPg and SN to GoPg, dentally the patient had retroclination of the maxillary incisors which locked the mandible in a retruded position. Superior airway space (SAS) was 8mm as compared to norm of 9-11mm and posterior airway space (PAS) was 8mm as compared to norms of 9-11mm. Acoustic pharyngometry revealed a Mean Pharyngeal Area (MPA) of 1.92cm^2 against the norms of ≥3.2cm^2, Minimum Pharyngeal Area (MIPA) was 1.28cm^2 and Pharyngeal Airway volume (PAV) was 19.01cm^3. The case was diagnosed as a skeletal class II malocclusion with retroclined maxillary incisors and a locked mandible. VTO of the patient and the airway parameters showed positive signs on advancing the mandible voluntarily on carrying out acoustic pharyngometry in this advanced position. The case was planned for orthodontic camouflage along with a fixed functional appliance (*FORSUS FRD*).

Result

In case 1 lateral cephalograms and acoustic pharyngometry were repeated after advancement which showed that superior airway space (SAS) increased from 7mm to 11mm and posterior airway space (PAS) increased from 6mm to 10mm, Mean Pharyngeal Area (MPA) of 2.37cm^2 increased to 3.93cm^2, Minimum Pharyngeal Area (MIPA) increased from 1.88cm^2 to 2.99cm^2 and Pharyngeal Airway volume (PAV) increased from 23.70 to 39.26cm^3 (Figure 1). These changes corroborated with our planned treatment. In case 2 eight months post fixed functional appliance therapy repeat lateral cephalogram and AP were carried out showing an increased superior airway space (SAS) from 8mm to 10 mm and a posterior airway space (PAS) from 8mm to 11mm. The Mean Pharyngeal Area (MPA) of 1.92cm^2 increased to 2.46cm^2, Minimum Pharyngeal Area (MIPA) increased to 1.79cm^2 from 1.28cm^2 and Pharyngeal Airway volume (PAV) increased to 24.58cm^3 from 19.01cm^3 (Figure 2). The changes achieved post treatment matched with pretreatment plan.

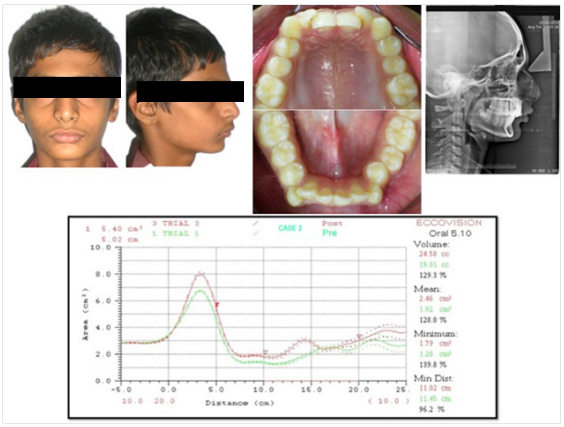

Figure 2 Pre treatments extraoral, intraoral, lateral cephalogram and pharyngogram- pre and post treatment trials.

Discussion

Orthodontic treatment aimed at protrusion of the mandible/surgical advancement of the mandible to treat hypoplastic/retro positioned mandible or camouflaging the skeletal problem using extractions as a treatment modality lead to changes in the airway dimension. These changes whether positive or negative can be accurately assessed at the diagnosis and treatment planning stage by the clinician to ensure a positive/ no detrimental effect on the quality of life of the patient, post orthodontic treatment with the procedure of our choice. Lateral cephalometry is routinely used for diagnosing facial skeletal abnormalities that may affect the airway directly or indirectly. The complexities of airway collapse due to airway narrowing arise from the possible involvement of multiple sites of potential airway compromise. Therefore, identification of the site(s) of upper airway obstruction is an important step in determining the treatment of choice.[9]

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Lateral cephalometry provides a static 2-dimensional representation for a dynamic 3-dimensional airway collapse; moreover, there is no single measurement that is adequate for prediction of the outcome of treatment.[10,11] Acoustic pharyngometry assesses the geometry of the oropharyngeal cavity by using a reflected acoustic signal emitted from the device and sent into the oropharynx. Computerized processing of the incident and reflected sound waves from the airway provides an area distance curve or Pharyngogram representing the lumen from which minimal cross-sectional area and volume can be derived. Consequently, reductions in the anatomical space-in particular the diameter- will produce changes in the intensity of the reflected wave and in the time taken for the reflected wave to return from a given anatomical structure to the microphone which are received and assessed. Acoustic pharyngometry is a useful objective tool in Orthodontic centers for screening of the airway in three dimensions. Orthodontic treatment is aimed at improving the general health and esthetics of our patients; hence our procedures post treatment should not give a severe health problem in the form of a compromised airway, AP helps us to screen this important anatomic structure at our planning stage of the treatment itself so that necessary modifications in the final plan and execution of the treatment may be done and severe life threatening problems may not occur due to our treatment.

Conclusion

The above cases presented with retrusion of the mandible, leading to decreased airway dimensions, which were screened by acoustic pharyngometry and planned treatment showed positive changes in airway dimensions. Acoustic pharyngometry is a valuable tool and is recommended for screening airway problems three dimensionally for routine orthodontic cases. It is a cost effective method as compared to its counterparts, for primary assessment of a compromised airway which shall be a valuable input during the diagnosis and treatment planning stage of any case.

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None.

Conflict of interest

The authors declare that there is no conflict of interest.

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