Three-dimensional analysis of pharyngeal airway in preadolescent children with different anteroposterior skeletal patterns

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**Introduction:** In growing patients with skeletal discrepancies, early diagnosis, evidence-based explanations of etiology, and assessment of functional factors can be vital for the restoration of normal craniofacial growth and the stability of the treatment results. The aims of our study were to compare the 3-dimensional pharyngeal airway volumes in healthy children with a retrogнатhic mandible and those with normal craniofacial growth, and to investigate possible significant relationships and correlations among the studied cephalometric variables and the airway morphology in these children.

**Methods:** Three-dimensional airway volume and cross-sectional areas of 27 healthy children (12 boys, 15 girls; mean age, 11 years) were measured by using cone-beam computed tomography volume scans, and 2-dimensional lateral cephalograms were created and analyzed. The subjects were divided into 2 groups based on their ANB angles (group I: $2^\circ \leq \text{ANB} \leq 5^\circ$; group II: ANB $>5^\circ$), and cephalometric variables, airway volumes, and cross-sectional measurements were compared.

**Results:** There were statistically significant differences in the following parameters: height of the posterior nasal plane ($P < 0.05$), pogonion to nasion perpendicular distance ($P < 0.01$), ANB angle ($P < 0.01$), mandibular body length ($P < 0.01$), facial convexity ($P < 0.01$), and total airway volume ($P < 0.05$). No statistically significant differences between the 2 groups were found in the cross-sectional area and the volumetric measurements of the various sections of the airway except for total airway volume, which had larger values in group I ($P < 0.05$).

**Conclusions:** The mean total airway volume, extending from the anterior nasal cavity and the nasopharynx to the epiglottis, in retrogнатhic patients was significantly smaller than that of patients with a normal anteroposterior skeletal relationship. On the other hand, differences in volume measurements of the 4 subregions of the airway were not statistically significant between the 2 groups.

Read the full text online at: www.ajodo.org, pages 306.e1-306.e11.

**EDITOR’S SUMMARY**

When you examine a patient with a Class II malocclusion and a retrogнатhic mandible, do you assume that he or she has reduced airway capacity? If so, on what do you base that assumption? The aims of this retrospective, cross-sectional study were to compare pharyngeal airway volumes of healthy children who had retrogнатhic mandibles with those of children who had normal craniofacial relationships and to investigate the correlation between cephalometric variables and airway morphology in these children.

Pharyngeal airway structures were studied in 27 children (mean age, 11.19 years) who were referred for orthodontic treatment. Cone-beam computed tomography (CBCT) scans were obtained of all subjects for volumetric rendering for airway and cephalometric analysis. Two-dimensional (2D) cephalometric images were derived from the 3-dimensional (3D) CBCT scans, and the images were imported into a cephalometric software program for conventional 2D analysis. Volumetric renderings were acquired with InVivoDental software (Anatomage, San Jose, Calif).

Because this was a retrospective study, few subjects were available; therefore, this should be considered a pilot study. The results showed that healthy preadolescents with retruded mandibles have decreased total pharyngeal airway volumes. Future investigations of longitudinal airway changes in patients with different skeletal patterns and assessments of their craniofacial growth with 3D superimpositions will allow better understanding of the relationship between respiratory function and craniofacial morphology.
Q & A

Turpin: Do you plan to enlarge this sample for more complete results? Could you follow these subjects in the long term to see whether airway volume continues to change?

Park: We are continually acquiring CBCT scans of many orthodontic patients at the start and the end of treatment, and we plan to enlarge the sample size for more reliable results. As you suggested, we have conducted a longitudinal study of airway changes in 2D lateral cephalometric radiographs and obtained some interesting results. We will definitely evaluate the 3D longitudinal airway changes in these subjects as well.

Turpin: In clinical practice, do you think it will ever be justifiable to take 3D computed radiographs to evaluate airway volume before orthodontic treatment?

Park: I believe that evaluation of functional factors with clinical influence on the dentofacial patterns is vital in treating malocclusion. Especially in growing children, these etiologic factors should be eliminated as soon as possible to prevent further aberrant growth of the craniofacial complex. Previous studies have confirmed that CBCT scans are more accurate in identifying size and shape of the airway than the 2D method of airway evaluation.

Turpin: How would you justify the increased radiographic exposure to the orthodontic patient?

Park: Three-dimensional information acquired from CBCT scans makes a substantial contribution to orthodontic diagnosis in patients with craniofacial anomalies that require functional assessment of the airway as a part of evidence-based etiologic explanations. Although it is prudent to minimize radiation exposure, certain criteria should be established to determine which patients will benefit from the 3D information in diagnosis and successful treatment. We obtain full field-of-view CBCT scans of children who need orthopedic treatment and adults with severe skeletal discrepancies of the jaws often indicated for orthognathic surgery.

Fig 4. Five cross-sectional planes of the pharyngeal airway used in this study: A, right lateral view and B, frontal view of volume rendered images. a, Anterior nasal plane (Ana); b, posterior nasal plane (Pna); c, upper pharyngeal plane (Uph); d, middle pharyngeal plane (Mph); e, lower pharyngeal plane (Lph). C, The cross-sectional planes are shown in the lateral cephalogram.