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Numerous Distinct Orthodontic Treatment Techniques Impacting The Airway Dimensions: A Critical Review

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Abstract

In this review, we assessed upon how various orthodontic treatments influence the dimensions of the airway. Almost a third of all cases of malocclusion that orthodontists treat involve Class II malocclusion. Class II malocclusion has been linked to narrower pharyngeal airways. Multiple techniques have been used to remedy this malocclusion. When it comes to making an orthodontic diagnosis and determining next steps in treatment, breathing plays a crucial role. The pharynx, skull, and teeth have all been linked in numerous studies. Multiple studies have found a correlation between sleep apnea and mouth breathing. Correcting bone or dental issues, or both, can alleviate the associated symptoms. Therefore, it would be extremely interesting to understand and interpret the airway during diagnostic and treatment planning to have a clear image of the changes in airway dimensions throughout the course of orthodontic therapy utilizing different treatment modalities. Therefore, it is crucial to have a thorough comprehension of the idea of an airway. In this review, we'll glance at how the various orthodontic and dentofacial orthopedic procedures depict shifts in pharyngeal airway dimensions as assessed by cone beam computed tomography (CBCT). The pulmonary airways benefit from distalization with a Carrière Motion appliance. The total upper airway volume was greatly expanded. Search terms: Airway measurements, CBCT, and orthodontic care.

Keywords: Orthodontic therapy; Airway dimensions; CBCT

Introduction

The cricoid cartilages, which extend from the nose and mouth into the larynx, are the second set of upper airways in humans. In the pharynx, where the oral and nasal chambers join, there are three distinct areas: the nasopharynx, the oropharynx, and the hypopharynx. The upper airway's capacity to transport air is proportional to its size and shape. There is a close anatomical relationship between the craniofacial, dental, and oral regions, which means they all influence one another. Normal craniofacial development depends on the ability to breathe and speak clearly via one's nose [1,2].

Since its likely involvement in normal craniofacial formation and its role in identifying mouth breathing and sleep disorders, airway analysis has piqued the interest of orthodontists. Clinicians need to do objective exams of the upper airway to recognize normal and abnormal anatomical borders and dimensions. Although two-dimensional lateral cephalograms have been utilized extensively for years to evaluate the shape, size, position, and connectivity of the airway to other anatomical structures, they do not provide sufficient information to portray the anatomically complex airway structure

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in three dimensions. Three-dimensional CBCT scans have far more comprehensive and reliable instruments for volumetric measures and airway evaluation than lateral cephalograms, which can be used as a preliminary screening strategy [1,2].

In order to evaluate the airways and provide precise volume values, three-dimensional CBCT scans are the gold standard. Its accuracy and precision in measuring airways were confirmed. The upper airway can be studied in 3D with CBCT, and the results will be accurate and reliable. The Carrière Motion appliance was developed by Luis Carrière and bears his name. Before beginning orthodontic treatment, the Carriere Motion Appliance method defines the patient's sagittal dimension to construct a Class I platform. During the first stages of treatment, when patient compliance is at its highest, the Motion Appliance is employed to correct cases to a Class I platform for the macro-repair of the occlusion. Depending on the patient's needs, a variety of fixed or aligner appliances can be used to complete the treatment [3].

Orthodontic treatment modality airway impacts

Orthodontists have traditionally focused a most of their attention on the oropharyngeal and nasopharyngeal structures to make sure that the craniofacial complex develops and grows correctly. This is because these structures are directly connected to the breathing system. The size of the oropharynx in developing patients who had maxillary constriction treated through rapid palatal expansion (RPE) was measured retrospectively using CBCT, and the results were compared to those of orthodontic patients who were the same age and gender as the developing patients. According to the findings, only the retropalatal airway volume was shown to be markedly statistically different prior to therapy. They came to the conclusion that developing individuals who had maxillary constriction also had constricted oropharyngeal airways [4].

The retraction of the anterior teeth in the pharyngeal airway was investigated by Bhatia et al [5]. The findings showed that there is a substantial association between the degree of lower incisor retraction and a reduction in the pharyngeal airway posterior to the soft palate. This relationship was discovered after doing research. They came to the conclusion that pulling the incisors back in the extraction gap decreased the pharyngeal airway size in adult patients with bimaxillary protrusion.

Celikoglu et al. [6] examined the pharyngeal and skeletal airway impacts of skeletally anchored Forsus FRD EZ appliance with bilateral miniplates placed on mandibular symphyses. They further compared these findings with very well-matched controls who were treated with Herbst appliances. It was discovered that effective therapies for skeletal Class II malocclusions include a reduction in SNA and an increase in SNB. There were substantial differences in the dimensions of the lower and upper pharyngeal airways in both groups; however, the only dimension of the lower pharyngeal airway that was demonstrated to be statistically significant was that of the upper pharyngeal airway size. According to their findings, the changes to the skeleton that were caused by both devices caused considerable modifications to the pharyngeal airway.

A three-dimensional analysis of the changes in airway volume that occurred after two expansion regimens with varied activation rates was carried out by Lotfi et al [7]. The findings demonstrated a considerable increase in nasal cavity capacity in both the control and experimental groups. An increase in volume was observed in response to a more rapid stimulation of the nasopharynx. As a consequence of this, they came to the conclusion that a quicker activation of the nasopharynx and nasal cavity led to a greater increase in volume.

Orthognathic maxillomandibular motions were found to have an influence on nasal and oro-nasopharyngeal airway morphology and function, as examined by Asai et al [8]. The results showed that neither the resistance of the nasal airways nor the volume of the nasal cavity changed significantly after surgery.

For this reason, Kumar et al. [9] conducted a retrospective evaluation to ensure that the extraction procedure had no negative impacts on the airway at any point in its anatomic development. When comparing the two study groups, researchers found that the average percentage change in soft palate width (NAS) was quite different. However, there were no significant differences in PAS, HAS, hyoid distance, or tongue length. There was no discernible difference in airway size before and after orthodontic treatment, regardless of whether extractions were performed. For the purpose of correcting mild skeletal class II and III malocclusions, Moscarino et al. [10] compared the influence of several camouflage and orthognathic treatments on the pharyngeal airway space. Results showed that only patients with Class II malocclusions benefited significantly from pre and post treatment.

Lee et al. [11] employed CBCT to explore the factors that affect three-dimensional alterations in pharyngeal airway space following mandibular setback surgery. They determined that maxillary posterior impaction was an effective alternative to mandibular setback surgery in treating obstructive sleep apnea due to the pharyngeal airway.

Oral cavity volume (OCV), tongue volume (TV), and the ratio between the two (TV/OCV) were measured and correlated with upper airway volume using CBCT by Rana et al. [12]. The authors concluded that there was a substantial negative correlation between oropharynx, TV/OCV, and oral cavity airway volume.

The impact of removing the second premolar on the size

Elghawy HAAA et al., Dent Res Oral Health 2023
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of the upper airway was studied by Aldosari et al. [13] in a sample of adult females undergoing orthodontic treatment. The patient's vertical airway was significantly lengthened after the second premolars were extracted.

Airway space after distalization using carrière motion appliance

The "Carrière Motion Appliance" is a revolutionary new device. Before any more braces or appliances are installed, the first maxillary molar is rotated and raised to a class I position. Next, the entire posterior segment is distalized, beginning at the canine and terminating at the molar. A variety of anchoring techniques, including as a lingual arch or a lower Essix appliance, may be used to avoid the protrusion of the mandibular incisors during appliance activation, as claimed by the inventor [14].

The first researchers to try to establish a connection between pharyngeal airway irregularities and pronounced skeletal asymmetry were Mergen et al. [15]. As a conclusion, patients with class II malocclusion have a lower nasopharyngeal depth and area. This was largely attributable to the retruded mandibular posture, which increases the risk of obstructive sleep apnea. Patients with Class II malocclusion had a narrower Oro- and hypopharyngeal space than those with Class I and normal occlusion, according to research by Kirjavainen and Kirjavainen [16].

Because of the airway's obvious possible role in normal craniofacial growth and development, including its participation in the treatment and diagnosis of sleep problems and mouth breathing, orthodontists have increased their interest in airway analysis. The upper airway must be examined objectively by clinicians in order to distinguish between normal and pathological anatomical borders and dimensions. Because of their lack of information, the two-dimensional lateral cephalograms that were applied for years to assess the airway's size and location relative to other anatomical structures are no longer effective. Airway examination can begin with lateral cephalograms, however, CBCT pictures give a more accurate and complete means of assessing and measuring the airway's volume than this screening approach. Instead of a fan-shaped X-ray beam, CBCT imaging employs a cone-shaped collimated X-ray beam [17]. Evidence of its precision and accuracy in airway measuring exists. A precise and dependable 3D study of the upper airway may be performed with CBCT [18]. Orthodontic computer software programs have created features for airway studies, notably for volume size assessment.

After maxillary and mandibular setback surgery, the airway volume decreases by 3 cm^3, according to an airway study by Hsieh et al. [19]. Extraction therapy decreased the oropharyngeal airway by 1-1.5 mm in the anteroposterior breadth, according to research by Wang et al. [20]. However, in patients who had extraction and maximal anchoring, the oropharyngeal airway narrowed by 2.1 mm and 3.8 mm, respectively, according to studies by Germec-Caken et al. [21]. After having four first premolars extracted, the cross-sectional areas of the glossopharynx and palatopharynx fell by 21.0 and 25.2%, respectively, as reported by Chen et al. [22].

The increased focus on airway analysis and the effects of various treatment modalities on the airway space has led to contradictory results in the published literature. Numerous studies [19-22] have revealed a diminution in pharyngeal airway size. For instance, Guilleminault et al. [23] hypothesized that patients undergoing extraction therapy were more likely to develop OSA. However, Larsen et al. [24] employed a large sample that was similar in terms of gender, age, and weight to find no association between premolar extraction therapy and OSA. The effects of distalization of the maxillary teeth on the airways of Class II patients who do not undergo extraction are unknown.

Class II intermaxillary elastics and the Carrière Motion appliance, which debuted in 2004, were used to distalize the entire posterior segment from the maxillary canine to the first molar. Moreover, both the time frame and the diameter of the elastics conformed to the technique shown by Luis Carrière [25]. Additionally, the Lingual Arch was selected as an anchorage device to reduce anchorage loss in the lower arch. Recent studies have addressed these airway changes by highlighting the fact that the forward movement of the jaw is the primary contributor to correcting the sagittal relationship in most Class II treatment mechanisms. As the mandibular arch and teeth are brought forward, the hyoid bone shifts to a new location, altering the size and shape of the posterior airway. Carrière Motion II uses Class II elastics to protract the mandibular arch, thereby increasing the size of the patient's airway. This results in an anterior movement of the tongue, which expands the airway [25].

Results are consistent with those found in a study by Attia et al. [26] that used cone-beam CT to look at the pharyngeal airway of Class II patients who had been equipped with the Carrière Motion II device (CBCT). Twenty adult patients with malocclusions who were treated using the Carrière Motion II device were examined retrospectively. In order to compare the overall airway capacity and the minimal cross-sectional area before and after treatment, CBCT pictures were analyzed with the assistance of Anatomage software. There was a statistical examination of the information gathered. When the Class II malocclusion was fixed with the Carrier Motion II device, the measured airway parameters went up a lot. However, no one else has examined how distalizing the maxillary dentition with the Carrière Motion appliance impacts breathing. However, the Carrière Motion appliance's impacts were like those of many other distalizing devices. When comparing the Herbst appliance to the skeletally anchored Forsus FRD EZ, Mevlut

Elghawy HAAA et al., Dent Res Oral Health 2023
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Celikoglu et al. [27] looked at the impact on the pharynx and skeleton. Patients who have mandibular retrusion, a Class II skeletal malocclusion, have been recruited for the study. Even though both the upper and lower pharyngeal airway diameters grew in the skeletally anchored Forsus FRD EZ group, the lower airway was found to be much longer. In a parallel study, C. Thereza-Bussolaro et al. [28] compared the effects of treating Class II malocclusion with intermaxillary elastics (IME) and the Forsus fatigue resistance device (FFRD) on oropharyngeal airway dimensions. Both types of orthodontic therapy resulted in a similar increase in the oropharyngeal airway, the study found. Cephalometric changes in the hyoid bone, pharyngeal airway, and soft palate (SP) after therapy of Class II malocclusion with the Forsus Fatigue Resistant Device (FFRD) and Twin-Block (TWB) were examined by Baka et al. [29]. McNamara's upper airway dimensions grew in the FFRD group, whereas the lower airway dimensions increased in the TWB group. However, Park et al. found that the oropharyngeal airway and MCA were significantly reduced in patients with distalized maxillary teeth. It's possible that the variety of home appliances at play here is to blame for the discrepancy. Neither the maxillary nor the mandibular arch was subjected to a balancing force. Thirty-three adults, half of whom had their teeth extracted and half of whom did not, each had a modified C-palatal plate (MCPP) placed. There was a moderately negative correlation between airway volume and MCA in the extraction group. This demonstrates how the airway capacity decreases with increasing distalization. On the other hand, this was not found in the control group that did not go through extraction [2]. However, Chou et al. [30] studied the effects of maxillary molar distalization utilizing a modified C-palatal plate on the long-term skeletodental development, volume, and changes in airway space in adolescents with Class II malocclusion (MCPP). Results showed that after distalization, there was only a 1.40 mm^3 and 7.54 mm^2 increase in total airway capacity and MCA, respectively. In addition, long-term monitoring did not indicate any appreciable variations in breathing space.

Conclusions

The results of recent studies appear to indicate that the Carrière Motion appliance increased both total airway volume and MCA. The oropharyngeal airway has endured the highest growth. This could be because the appliance is employing Class II elastics that distalize the mandibular arch and induce mesial movement of the maxillary arch. This causes a widening of the tongue gap because the position of the hyoid bone alters the size of the posterior airway. Several methods have been proposed for evaluating airway dimensions after orthodontic therapy. We conclude, within the scope of this study, that there is a strong association between significant changes in upper airway dimensions and various orthodontic treatment techniques for the correction of Class II patients. The current review focuses on distalization. The use of a Carrière Motion appliance allowed an increase in airflow to the upper airway. The expansion of the upper airway increased total airway capacity significantly.

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Elghawy HAAA et al., Dent Res Oral Health 2023
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