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Effects of functional appliances on pharyngeal airways in patients with class II malocclusions: a literature review

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Abstract

Class II malocclusions may be classified into four main groups: protrusive maxillary dentition, maxilla protrusion, mandibular deficiency and excessive or deficient vertical development. Mandibular deficiency seems to be the most frequent characteristic in class II malocclusions. Severe mandibular deficiency can reduce the space present between the cervical column and the mandibular body which may lead to posterior positioning of the tongue and soft palate causing impairment in the oropharyngeal airway dimension. Functional treatment can advance mandibular position, incrementing the space between the mandibular body and the cervical columns. The aim of the review is to establish if mandibular functional advance can increase pharyngeal airways dimensions. 11 articles were selected, according to inclusion and exclusion criteria. All studies showed different positive effects on posterior airways as results of functional orthodontic treatments with some specific appliances. Mandibular advance in the correction of class II malocclusion is capable to increase the dimensions of pharyngeal airways.

Introduction

Class II malocclusions may be classified into four main groups: protrusive maxillary dentition, maxilla protrusion, mandibular deficiency and excessive or deficient vertical development (1,2). McNamara stated that most Class II patients present a deficiency in the anteroposterior position of the jaw (3). Mandibular deficiency can be attributed to a small or retruded mandible relative to the maxilla. According to Edward Angle, when a normal function is established, the adaptation of the craniofacial morphology subsequently follows it (4). Skeletal modifications in young children, during the growth phase, can be achieved by using functional treatment. In class II malocclusion patients a first skeletal class relationship can be obtained with functional appliances which can advance and stabilize mandibular position, by enhancing the proprioceptive sensory feedback mechanisms of various perioral musculatures that control the function and position of the mandible and transmit the generated forces to the dentition and basal bone (5,6). Severe mandibular deficiency can reduce the space present between the cervical column and the mandibular body which may lead to posterior positioning of the tongue and soft palate causing impairment in the oropharyngeal airway dimension increasing the chances of impaired respiratory function and possibly causing problems such as snoring, upper airway resistance syndrome, and obstructive sleep apnea or hypoapnea syndrome (7,8). Other authors concluded that the interrelationship between the mandibular position and airway dimension is unproven (9,10). The aim of the research is to establish the effects of functional appliances on oro-pharyngeal airways.

Materials and Methods

The review was conducted by consulting three different databases: Pubmed (Medline), Google Scholar and Scopus, from 2000 to 2017. A combination of the following key words was used: *oropharyngeal airway, airway dimension, class II malocclusion, functional appliances, nasopharyngeal airway, mandibular position*. Review articles, systematic reviews, case-control studies, randomised studies were included. Instead, studies which involved syndromic patients were excluded.

Review

According to inclusion and exclusion criteria, 11 articles were excluded. Godke S et al in 2014, concluded that correction of mandibular retrusion by twin-block appliance in class II malocclusion subjects increased the pharyngeal airway passage (PAP) dimensions and maintained the pretreatment thickness of posterior pharyngeal wall. The depth of the oropharynx was increased significantly in the treatment group subjects ($P< 0.001$) as compared to the control group subjects ($P< 0.05$). Ali B et al in 2015, concluded that Functional appliance therapy can improve the narrow pharyngeal airway of growing children presenting with deficient mandibles having Class-II skeletal pattern. In particular, the upper airway width ($p< 0.001$), nasopharyngeal depth ($p=0.03$) and upper airway thickness ($p=0.008$) was substantially improved after CTB treatment. Males showed a greater increase in upper airway width ($p=0.03$) and nasopharyngeal depth ($p=0.01$) in comparison to the females (12). Hourfar et al in 2016, stated that both appliances as S-II-appliance or Activator similarly led to an increase of the pharyngeal depth. The sites of statistically significant changes differed. Changes were more pronounced in S-II patients. In contrast to intergroup comparisons, some intragroup comparisons revealed statistically significant differences at levels P5 ($p=0.0062$) and P6 ($p=0.0155$) in S-II patients and at P1-level ($p=0.0197$) in Activator patients. Isidor S et al in 2000, affirmed that an increase in the upper airway volume was found after treatment with functional appliances. This difference was mainly related to the changes at the oropharynx level, which differed significantly from what was observed in the Class I group. In the functional appliance group, all the partial and total volumes were significantly larger at the end of treatment when compared to the start of treatment ($P< .003$). On the other hand, when comparing the changes for the total and partial volumes of the upper airway in the functional appliance group with the Class I group, a statistical difference was seen only for the oropharynx ($P=.022$) and total volume ($P= .025$), with the functional appliance group showing a larger volume increment. (14). Iwasaki et al in 2014, concluded that the Herbst appliance enlarges the oropharyngeal and laryngopharyngeal airways. These results may provide a useful assessment of obstructive sleep apnea treatment during growth. The increase of the oropharyngeal airway volume in the Herbst group (5000.2 mm3) was significantly greater than that of the control group (2451.6 mm3). Similarly, the increase of the laryngopharyngeal airway volume in the Herbst group (1941.8 mm3) was significantly greater than that of the control group (1060.1 mm3) (15). Iwasaki T et al in 2017 confirmed that the Herbst appliance improves ventilation of the oropharyngeal and laryngopharyngeal airways. These results may provide a useful assessment of obstructive sleep apnea treatment during growth. The change in oropharyngeal airway velocity in the Herbst group (1.95 m/s) was significantly larger than that in the control group (0.67 m/s). Similarly, the decrease in laryngopharyngeal airway velocity in the Herbst group (1.37 m/s) was significantly larger than that in the control group (0.57 m/s) (16). Kannan A, et al in 2017, concluded that significant increase in the dimensions of nasopharynx and oropharynx was observed with Activator. Significant increase in the nasopharynx and hypopharynx (male patients) was observed with Bionator. Insignificant increase in the oropharynx was observed with the same. Significant increase in the oropharynx and hypopharynx was observed with Twin Block. Insignificant increase in the nasopharynx was observed with the same. Significant increase was observed only in the hypopharynx for Frankel II. Decreased or insignificant change was observed with FMA, MPA IV, and Herbst appliances (17). Ozdemir F, et al in 2014, concluded that the dentoalveolar changes produced by Forsus FRD appliance did not cause any significant posterior airway changes in young adult patients (18). Rizk S, et al in 2000, asserted that Functional appliance therapy increases oropharyngeal airway volume, airway dimensions, and anteroposterior hyoid bone position in growing patients (19). Ulusoy C, et al in 2014, established that in growing Class 2 patients with mandibular deficiency and airway track without obstructions, functional appliance treatment provided favorable effects on nasopharyngeal and oropharyngeal area throughout the retention period. During treatment (T2-T1), nasopharyngeal height and nasopharyngeal area increased ($p< 0.05$) and hyoid bone moved downward (H-SN; $p < 0.001$) and forward (H-C3; $p< 0.01$). During retention period (T3-T2); nasopharyngeal ($p< 0.01$) and oropharyngeal area increased ($p< 0.05$). H-SN ($p< 0.01$) and C3-H distances ($p< 0.05$) increased. Hyoid bone position exhibited significant changes (H-SN, $p< 0.001$; C3-H, $p< 0.01$). The increases in C3-H in long-term was more in the activator group than control ($p< 0.05$) (20). Xiang M, et al in 2017, showed that FAs can enlarge the upper airway dimensions, specifically in the oropharyngeal region, in growing subjects with skeletal Class II malocclusion. The early intervention for mandibular retrognathism with FAs may help enlarge the airway dimensions and decrease potential risk of obstructive sleep apnea syndrome for growing patients in the future. As results, five articles confirmed an increase of upper airway width. Nine articles showed an increase of oropharyngeal depth. In four studies nasopharyngeal depth was increased. Three articles underlined an enlarge of laryngopharyngeal airways. Finally, one study demonstrated that any posterior airway changes resulted after skeletal changes.

Conclusion(s)

All studies showed different positive effects on posterior airways as results of functional orthodontic treatments with some specific appliances such as twin-block, activator, bionator and Herbst. In particular, mandibular advance in the correction of class II malocclusion is capable to increase the dimensions of pharyngeal airways: oropharyngeal depth, airway width, nasopharyngeal depth and laryngopharyngeal depth. Further original articles could be conducted in order to confirm these relationship.

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