Effectiveness of twin-block appliance in the improvement of pharyngeal airway passage dimensions in subjects with obstructive sleep apnoea syndrome (OSAS)

Peer review status:
No

Corresponding Author:
Dr. Valentina Caridi,
Odontoiatra, Scienze odontostomatologiche e Maxillo-Facciali Roma - Italy

Submitting Author:
Dr. Valentina Caridi,
Odontoiatra, Scienze odontostomatologiche e Maxillo-Facciali Roma - Italy

Other Authors:
Dr. Gabriella Galluccio,
Direttore della Scuola di Specializzazione in Ortognatodonzia , Scienze Odontostomatologiche e Maxillo-Facciali, Roma La Sapienza - Italy

Article ID: WMC004466
Article Type: Systematic Review
Submitted on: 16-Dec-2013, 03:59:22 PM GMT Published on: 17-Dec-2013, 05:28:07 AM GMT
Article URL: http://www.webmedcentral.com/article_view/4466
Subject Categories: ORTHODONTICS
Keywords: pharyngeal airway passage, functional appliance, Twin-block

How to cite the article: Caridi V, Galluccio G. Effectiveness of twin-block appliance in the improvement of pharyngeal airway passage dimensions in subjects with obstructive sleep apnoea syndrome (OSAS). WebmedCentral ORTHODONTICS 2013;4(12):WMC004466

Copyright: This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC-BY), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Source(s) of Funding:
None

Competing Interests:
None
Effectiveness of twin-block appliance in the improvement of pharyngeal airway passage dimensions in subjects with obstructive sleep apnoea syndrome (OSAS)

Author(s): Caridi V, Galluccio G

Abstract

The incidence of sleep-disordered breathing (SDB) among school-aged children is approximately 2–10% and narrowing of the pharyngeal airway passage (PAP) is a common feature in these patients. Classical presentations of sleep disordered breathing in children, such as snoring and obstructive sleep apnoea as well as their clinical implications have been greatly neglected and underestimated in the past. There are significant relationships between the pharyngeal dimensions and craniofacial abnormalities. In children and adolescents with SDB the position of the mandible is more retrognathic in relation to the cranial base. Through a careful analysis of the scientific literature, we want to analyze the correlation between PAP dimensions among subjects with normal, retrognathic, and prognathic mandibles and their vertical growth pattern of the mandible; they were chosen from several publications that analyze the twin-block’s effects in improving the pharyngeal airway passage (PAP) dimensions among Class II malocclusion subjects with a retrognathic mandible. Functional appliances contribute to Class II correction in growing patients through a combination of dentoalveolar and skeletal effects. Skeletal change has been shown to account for approximately one-third of the decrease in overjet that is seen in successful cases, with the remainder predominantly maxillary incisor retroclination.

Introduction

The interest in paediatric sleep disorders over the last few decades has had its main focus on the sudden infant death syndrome (SIDS) – healthy infants who go to sleep and never wake up again. By contrast, classical presentations of sleep disordered breathing in children, such as snoring and obstructive sleep apnoea as well as their clinical implications have been greatly neglected and underestimated in the past. Snoring in children has so far generally been regarded as noisy breathing with no significant impact on the general health of children. This is an obstructive sleep apnoea syndrome (OSAS), sometimes its dramatic complications, such as cor pulmonale and developmental retardation have at least indicated that OSAS in children is important and may have a great impact on the general health of children. The growth and function of nasal cavities, the nasopharynx and the oropharynx are closely associated with the normal growth of skull. The size of nasopharynx increases in conjunction with the growth of the cranial base and forward development of mid face. Obstructive sleep apnoea (OSA) is a potentially life-threatening disorder where repeated collapse of the upper airway during sleep causes cessation of breathing. OSA is diagnosed where five or more abnormal respiratory events occur for hours (Guilleminault et al., 1978) but is only considered clinically significant where at least 20 such events are present (Riley et al., 1983). The abnormal respiratory events may be apnoeas or hypopnoeas. An apnoea is defined as a break in respiration is present but there is a reduction in tidal volume leading to a drop in blood oxygen saturation of 4 per cent or more, which lasts for 10 seconds or longer. Oral appliances are increasingly advocated as a treatment option for obstructive sleep apnoea (OSA). However, it is not clear how the different designs influence treatment efficacy in children. Mandibular protruding devices (MPDs) have become popular because of their effectiveness in treating sleep disordered breathing (Bonham et al., 1988; Marklund et al., 1998; Wilhelmsson et al., 1999. Clark et al. 1993) recommended that MPDs should be constructed to position the mandible forward by 75 per cent of the maximum range of protrusion. In a number of studies, the degree of maximal mandibular advancement has varied (Clark et al., 1993; Ferguson et al., 1996, 1997; Tegelberg et al., 1999; Yoshida, 2000; Gavish et al., 2001), but details of how this measurement was determined were not reported.
We carried out a careful analysis of the scientific literature about the mandibular protrusion in the treatment of obstructive sleep apnoea and snoring with a mandibular protruding device. We were chosen from "PubMed" several publications about pharyngeal airway passage, functional appliance, Twin-block and Mandibular Protraction Appliance. There are various removable and fixed functional appliances used routinely to stimulate mandibular growth in skeletal Class II growing patients. Similar oral appliances are also used in adult OSA patients to prevent upper airway collapse during sleep. Although there are numerous studies those have evaluated the nature of Class II correction by various functional appliances in growing skeletal Class II children, there are only a few studies that mention the PAP dimension changes following functional appliance treatment.

Nasal continuous positive airway pressure (CPAP) is the current treatment of choice, but its cumbersome nature makes tolerance and compliance less than optimal. This gives rise to the need for other alternatives that are equally effective, but more tolerable. There is growing interest in the use of oral appliances to treat snoring and OSA. The rationale is that advancement of the mandible and tongue impacts positively on upper airway caliber and function. There are many such types of appliances.

The mandibular protruding device (MPD) is one method of treating both obstructive sleep apnoea (OSA) and snoring. We selected a studies in which were evaluated the following aspects of the MPD: subjective and objective effects on sleep, influences on airway passages and hard tissues, and the incidence and types of adverse events of the masticatory system including temporomandibular disorders. Twin Blocks (TBs) designed by Clark (1982) are traditionally used in the treatment of children with class II skeletal relationship. TBs have proved to be the best tolerated and most robust of all functional appliances (Clark, 1988; Parkin et al., 2001). The forward posturing of the mandible during wear makes the TB an obvious candidate for a MAS (mandibular advancement splint) in adults. With respect to OSA, TBs offer certain advantages. Like the one-piece monobloc and activator designs, they are relatively simple to construct yet, are readily adjustable. This allows the mandible to be gradually advanced to a position of maximal comfortable protrusion, which is associated with optimal reduction in OSA symptoms (Lowe et al., 1995).

Review

Myofunctional appliances are commonly used for correction of skeletal Class II malrelationship. These appliances influence craniofacial and nasopharyngeal dimensions. We reported a study of Vinoth et al., in which they analyzed cephalometric assessment of airway was done in 25 growing children in the age group of 11-13 years with Class II skeletal pattern. All the patients were treated with twin block appliance. Pre and post treatment lateral cephalograms were taken to evaluate the changes in different airway and craniofacial dimensions during the treatment period. The average treatment duration was 14.5 months; treatment was considered to be successful when the patient completed treatment with a pleasing profile and by using photographs, lateral caphalogram and casts. During treatment skeletal malrelationship improved as the mandible grew forward during the treatment. The change in SNB angle was on average 880°; the change in ANB value was on average -1.40°, the change in effective mandibular length on average 1.62 mm, which was highly significant. The change in area of bony nasopharynx value from pre-treatment to post treatment was on average 24.6 mm², and the change in ramal height value from pre-treatment to post treatment was 1.08 mm (highly significant). The change in upper pharyngeal width value from pre-treatment to post-treatment on average was 1.28 mm, and the change in lower pharyngeal width value from pre-treatment to post treatment was 1.66 mm². O'Brien K. et al's study evaluated the effectiveness of early orthodontic treatment with the Twin-block appliance for the developing Class II Division 1 malocclusion. A total of 174 children, aged 8 to 10 years old, with Class II Division 1 malocclusion were randomly allocated to receive treatment with a Twin-block appliance or to an untreated, control group. Data were collected at the start of the study and 15 months later. Results showed that early treatment with Twin-block appliances resulted in reduction of overjet, correction of molar relationships, and reduction in severity of malocclusion. Most of this correction was due to dentoalveolar change, but some was due to favorable skeletal change. Early treatment with the Twin-block appliance is effective in reducing overjet and severity of malocclusion. The small change in the skeletal relationship might not be considered clinically significant. Yaqoob et al's study, they prescribed a different appliance for two groups: Group 1 incorporated a passive upper labial bow (CTB-LB); Group 2, the appliance was constructed with no labial...
bow (CTB-NLB). Results of the cephalometric analyses of both groups are described: the maxillary incisors retroclined by more than 10 degrees among participants treated with the CTB-LB in Group 1; the corresponding value was 2.4 degrees less for those treated with the CTB-NLB in Group 2. However, ANOVA confirmed that no statistical difference was noted between the presence of an upper labial bow and maxillary incisor inclination change during treatment (P = 0.94). Anterior face height increased by 5.83 mm (SD = 5.51 mm) in Group 1 and by 5.53 mm (SD = 3.99 mm) in Group 2; however, no statistically significant difference was observed between appliances. The maxillary-mandibular planes angle (MMPA) increased by 0.63 degrees (SD = 1.83 degrees) in Group 1, in contrast to 0.37 degrees (SD = 2.22 degrees) in Group 2. Again, no statistical difference between groups was noted. The ANB angle decreased by 2.83 degrees (SD = 1.2 degrees) in Group 1 and by 3.07 degrees (SD = 1.51 degrees) in Group 2, reflecting a slightly greater decrease in SNA in Group 1 (SD = 1.03 degrees) and an SNA value that was almost unchanged in Group 2. Conversely, SNB increased slightly more in Group 2, although this difference failed to reach statistical significance (P = 0.86). The mandibular incisors were proclined relative to the mandibular plane in both groups. The amount of proclination increased by 4.63 degrees (SD = 3.6 degrees) in Group 1 and by 5.33 degrees (SD = 4.44 degrees) in Group 2. Mandibular first molars moved anteriorly by 5.40 mm (SD = 3.07 mm) and 6.63 mm (SD = 2.63 mm) in Groups 1 and 2, respectively. Maxillary molars were distalized slightly in both groups (range, 0.4–0.53 mm). Pogonion moved forward by 4.5–6 mm in both groups, with 1.5 mm more forward movement arising in Group 2. However, the intergroup difference also failed to reach statistical significance (P = 0.93).

**Discussion**

Initial side-effects experienced by the patients included muscular and TMJ discomfort, excessive salivation and a dry mouth or abnormal bite on walking. In common with other studies, these effects had reduced after 4-6 weeks of splint wear. The prevalence of muscular and TMJ discomfort and an abnormal bite was lower in patients with TB appliance. This may be related to the fact that its design requires greater vertical opening, allowing the mandible to rotate downwards as it comes forwards, relieving the pressure on the TMJ and muscles of mastication. Complaints of a dry mouth on walking and increased salivation, were high, and had altered little at the 4-6 week review. Small pharyngeal dimensions established early in life may predispose one to sleep-disordered breathing later when subsequent soft tissue changes caused by age, obesity, or genetic background further reduce the available oropharyngeal airway. Therefore, it can only be regarded as beneficial if functional appliance treatment in children or surgical mandibular advancement results in permanent increase in PAP dimensions. The most prominent finding of the present study of Ashok Kumar Jena et al., was improvement in the DOP (depth of the oropharynx) among treatment subjects. This improvement among subjects treated by twin-block appliance was greater than that in subjects treated by MPA-IV. Mandibular advancement by the functional appliances caused forward relocation of the tongue and increased the DOP. Many investigators have also reported a similar observation following various functional appliance therapy. We found only 0.85 ± 1.56 mm of improvement in the oropharynx depth by MPA-IV, whereas this improvement measured 2.12 ± 1.81 mm in those treated by twin-block. The greater improvement in the DOP among twin-block subjects could be due to more forward movement of the mandible. The DHP (depth of the hypopharynx) was marginally improved in our untreated Class II subjects and in those subjects in whom the Class II malocclusion was corrected by MPA-IV, but it was significantly improved in twin-block subjects. Significant forward movement of the mandible could be responsible for such a change. A very limited number of studies evaluating 3-dimensional soft tissue changes after functional treatment have been published. Only one clinical trial and a report of two cases have evaluated the 3-dimensional soft tissue changes that are produced with the twin block appliance. The main limitation of the clinical trial was that it presented the results as subjective visual changes rather than actual volumetric changes. Future studies using similar technology should also consider quantification of the volumetric changes. A recent article evaluated the aesthetic perception of different facial relationships in 2-dimensional and 3-dimensional formats. Fransson A. et al. noted, during the 2-year follow-up, a significant reduction of the subjective complaints in 90% of the MPD users. In the objective evaluation, the oxygen desaturation index (ODI) of the OSA group (n = 39) decreased significantly from a mean of 14.7 to 3.1 and the mean arterial oxygen saturation (SaO2) increased significantly from 78% to 89%. The snorers maintained their initial values. In the total group, MPD treatment significantly increased most pharyngeal measures and lifted the hyoid bone.
The pharyngeal area decreased significantly - by more than 50% - when the patient was supine, and the velum area increased significantly. At the 2-year follow-up, on upright cephalogram without MPD, the pharyngeal area had significantly increased and the velum area had significantly decreased. The mandible was posteriorly rotated (P < 0.01) as well as the lower incisors were proclined (P < 0.05). Mandibular advancement and vertical opening with an MPD, as measured with a ruler, compared well with measurements taken from a cephalogram. At the 2-year follow-up significant changes in the mean mandibular range of protrusion (+0.6 mm), overjet (-0.5 mm), and overbite (-0.8 mm) were registered. Nine of the 65 patients had developed a lateral open bite, and 2 were aware of the change. The reported frequency of headache was significantly reduced. At the 2-year follow-up there was a significant reduction in pain during mandibular movements.

Conclusion(s)

MPD treatment significantly reduced subjective complaints of sleep disturbances and significantly reduced ODI values among OSA patients. A high MPD compliance rate after 2 years indicated a well-tolerated treatment and a low rate of side effects were noted. The key factor in OSA and snoring is the obstruction of pharynx. The MPD treatment significantly increased the pharyngeal passages and significantly reduced the size of velum and thereby facilitated the breathing. Changes produced by the twin block appliance in the upper lip seem to be controversial, although the study with sounder methodological quality did not report significant changes.

References

2. Moellerb; SWISS MED WKLY 20 07:137:689–694
(September 2006)
15. “Effects of twin block appliance on obstructive sleep apnea in children: a preliminary study”; Chen Zhang, Hong He, Peter Ngan; Sleep and Breathing, December 2013, Volume 17, Issue 4, pp 1309-1314