Improving the adult dental arch, and airway, through bio-engineering and dentofacial orthopedics

Theodore R. Belfor and **Derek Mahony** explain the benefits of an intraoral removable, functional orthopedic/orthodontic appliance

Abstract

High palates, narrow dental arches, increased overjets, large body mass (BMI), and large neck size have been shown to indicate high risk factors for obstructive sleep apnea (OSA) (Kushida CA et al, 1997). To reduce the risk of OSA it has been recommended that children, with narrow dental arches and high palates, be treated with rapid palatal expansion (Villa MP et al, 2007). If an individual does not have a large neck, or high BMI, than the predictive factors for OSA are a high palate, narrow dental arch, and increased overjet. These characteristics are classical signs of malocclusion and can be associated with mouth breathing, a tongue thrust, and poor tongue posture. These developmental issues however, are rarely treated in adult patients. It is the purpose of this article to present an intraoral removable, functional orthopedic/orthodontic appliance (The Homeoblock™). In adult patients, the Homeoblock™ appliance has been shown to remodel the dental alveolus, to wider proportions, and to reduce the patient's overjet. The Homeoblock™ appliance is worn at nighttime only. Cases have been selected that demonstrate positive affects on the size of the pharyngeal airway, which in turn should enhance breathing as a result of better airflow volume.

Education aims and objectives

The aim of this article is to demonstrate the benefits and advantages of the Homeoblock appliance through a series of case studies.

Expected outcomes

The reader will be able to understand the outcomes of the case studies and see how the airways of the patients have been increased and positive results have been achieved.

Introduction

It has been shown that Homeoblock™ treatment has discernable affects on the maxillary arch, and face, in the correction of mild Class I and Class II malocclusions (Singh GD and Belfor TR, 2004). The case studies presented in this article show a pattern of poor swallowing and tongue posture. The appliance exhibits the ability to overcome and correct adult swallowing habits. We see changes in the alveolar arch, from the familiar 'V' shape to the more desirable 'U' shape, which provides more room for the tongue. Improved tongue position can affect the paryngeal airway. In accordance with Melvin Moss' Functional Matrix Hypothesis, the functional matrix is comprised of all the tissues, organs, and glands carrying out a specific function, such as mastication and swallowing. Moss theorised that the bone responds dynamically to changes in function. Hence by altering the function of swallowing we present a dynamic for the change in the shape of the bone. Furthermore, it is now recognised that craniofacial structure is a result of environmental and gene interaction (Moss, ML, 1997). We postulate the changes shown in the Homeoblock patients result from gene expression.

Figure 1

Treatment protocol

Full upper and lower dental models are taken with poly-vinyl siloxane impression material, CBCT scans, facial photos, and intra-oral photos are taken to establish baseline records. Upper and lower Homeoblock™ appliances are fabricated. The Homeoblock™ (Figure 1) consists of "Adams clasps" on the bicuspids with a base-plate that incorporates a palatal expansion jack screw. The appliance is relieved from the palatal tissues. Flap springs rest on the anterior teeth, and a Hawley archwire extends from canine to canine. On the less developed side a bite block is placed on the second bicuspid. Bird beak pliers, and/or three prong pliers, are used for clasp adjustment (Figure 2).

Initially each patient wore the appliance for

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one week without activation. The appliance was advanced ½ turn 0.125mm after the first week and again each successive week. The patient is advised to wears the appliance from 3pm to 8am, each night. Each patient was seen after three weeks and the patient's tolerance, fit, and compliance were reviewed. Post treatment intraoral, facial photos and CBCT scans were taken.

Case study I

A female patient, with an anterior tongue thrust habit, shows her tongue between her teeth before treatment and an improvement of her open bite after treatment. (Note change in archform from a 'V-shape' to a 'U-shape').

Case study II

A female patient, with poor tongue posture during swallowing, shows tight facial musculature before treatment and is more relaxed after treatment (Note upper arch development).

Case study III

A female patient, with a 10mm AP airway before treatment, and 15 mm AP airway after treatment. The red area shows the improved airway (Figure 9).

In Figure 10, the red area shows the improved airway. Figure 11 shows the improved airway size. In Figure 12 we can see that the posterior tongue and airway has improved by becoming more symmetrical. When we enhance symmetry we enhance function.

Case study IV

A male patient presented, with severe OSA before treatment, and is healthy after undergoing Homeoblock ™ treatment for 12 months. In Figure 13, the red area shows an increase in airway size.

Conclusion

Enlow, DH (1983) indicates that intra membranous bone (maxillary) is particularly sensitive to biological stresses and strains. A typical response to tension would be osteobastic activity and deposition of bone. When muscle and bone growth is complete, the body attains biological equilibrium and bone growth ceases. Introducing intra-oral tension on the palatal and alveolar bone, in adults, stimulates the re-emergence of osteoblostic activity and bone growth.

Discussion

Many of our patients with Sleep Apnea also have underdeveloped maxillae and narrow

Case study I

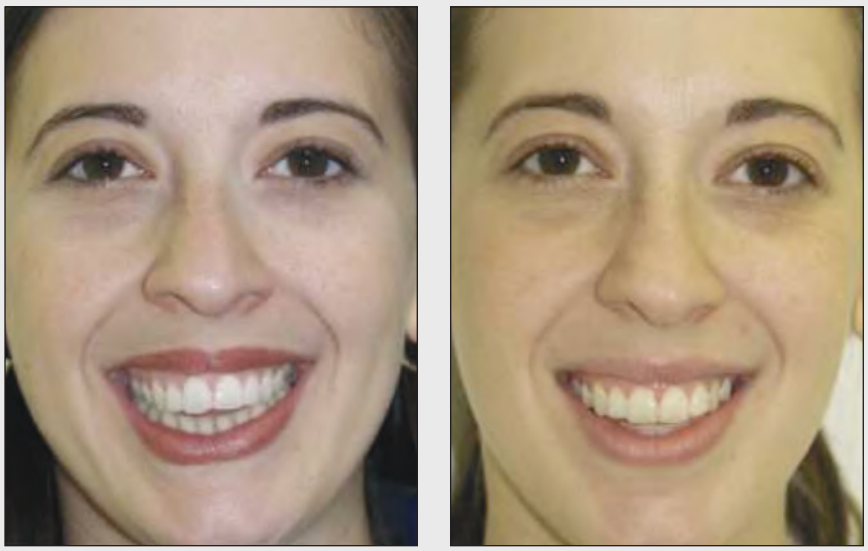

Figure 2

Figure 3a

Figure 3b

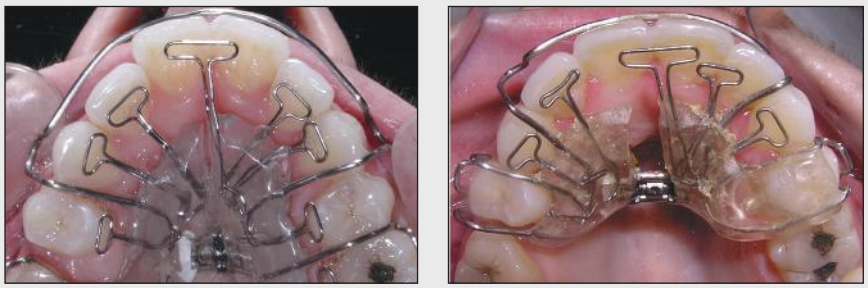

Figure 4a

Figure 4b

Figure 5a

Figure 5b

Case study II

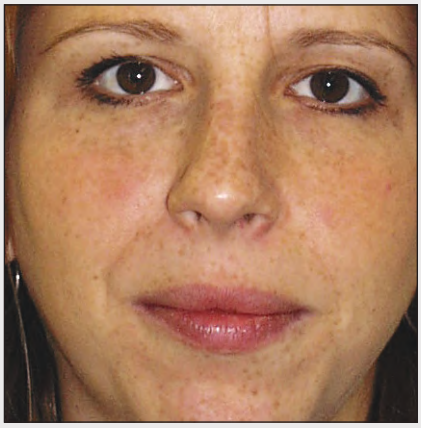

Figure 6a

Figure 6b

Figure 7a

Figure 7b

Figure 8a

Figure 8b

Case study III

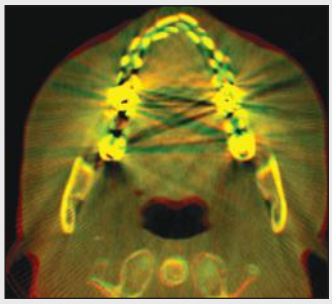

Figure 9a

Figure 9b

Figure 10

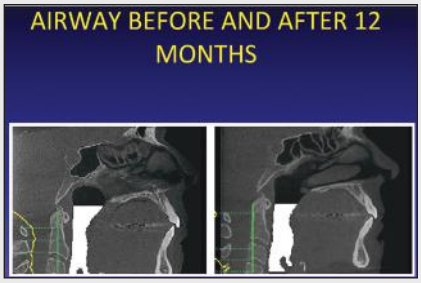

Figure 11

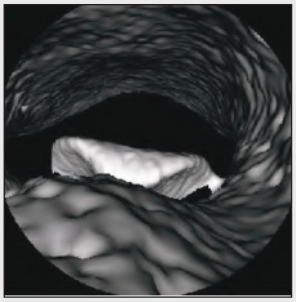

Figure 12a

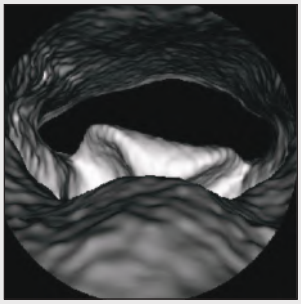

Figure 12b

Case study IV

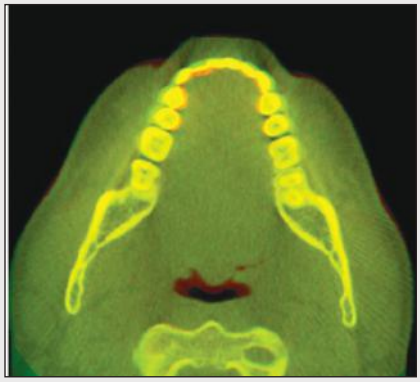

Figure 13

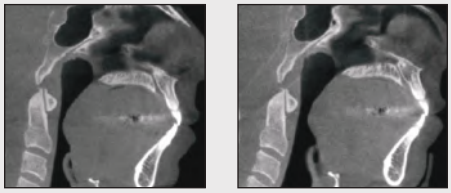

Figure 14 a and 14b

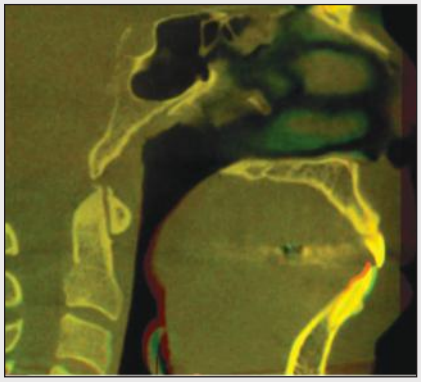

Figure 15

dental arches (less than 38mm between upper first molars). They may also present with skeletally retruded maxillae and/or mandibles. These patients may benefit from maxillary, and mandibular development, with an orthopedic/orthodontic removable dental appliance. Recent research suggests that the facial and circum-maxillary sutures remain open until late adulthood (Kokich VG, 1986). One of the earliest observations, which formed the basis of Moss' Functional Matrix Hypothesis, is that formation of bone can be stimulated by the separation of sutures (Moss ML, 1997).

This formation of the bone provides a developmental mechanism for continued maxillofacial morphogenesis. It is suggested that the Homeoblock™ appliance exerts tension on the periosteum, via the base plate, expansion screw, and bite block. Flap springs exert intermittent light forces and tension on the periodontal ligament, which widens as the suture widens. The intermittent light forces stimulate remodelling of the alveolar bone. Intermittent, light forces provided by the bite block, during swallowing, affect the cranial sutures. The cranial sutures activate and bone remodeling can occur. Enlow, DH (1983) uses the term, rotation, to describe a combination of positional and shape changes that occur as the maxillary is remodeled via palatal expansion. An upward and forward maxilla rotation helps the mandible to reposition forward, thereby improving the airway. Maxillary palatal expansion, and concurrent morphogenesis, can widen the nasal choanae. The floor of the nasal cavity may also widen and improve nasal airflow, creating additional room for the tongue. The tongue posture is improved due to the wider palatal space. The body is encoded for skeletal symmetry. Development enhances symmetry; therefore we conclude that enhanced symmetry results in improved function. We postulate that development resulting in symmetry improves neural harmony. Improved ninth and twelfth nerve harmony could result in the improved pharyngeal airway size that we see in the patient case studies.

If we understand Bernoulli's Principle we know that 'the pressure of a fluid [liquid or gas] decreases as the speed of the fluid increases.' Consequently, the airflow in the oropharynx increases as the tongue begins to compromise the airway and this lowers the pressure inside the airway. The walls of the airway begin to collapse, due to the higher pressure on the outside. The body's natural response is to resist the collapse, and tone up the walls of the airway, as well as the posterior part of the tongue. Research tells us that upon inspiration we release neurotransmitters that signal the ninth and twelfth nerves to tone the muscles. The theory is that when we are functioning optimally we do not suffer from sleep apnea. When this protective mechanism is not functioning, the airway will collapse and result in an OSA event. Research is currently underway to show that Homeoblock™ treatment stimulates craniofacial development, and enhances symmetry, within bone. We postulate that enhanced facial symmetry results in enhanced function and an improvement of ninth and twelfth nerve responses. These nerves tone the airway and reduce sleep apnea. A

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