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EDITORIAL

Orthodontics and sleep-disordered breathing

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Today, the field of orthodontia plays an important role in the diagnosis and treatment of sleep-disordered breathing syndromes. Oral appliances have been used to treat mild-to-moderate obstructive sleep apnea [1]. Objective evaluation of oral appliances with polysomnography is not routinely performed, thereby making long-term follow-up reports on the efficacy of these devices sparse. There has been a shift from monobloc dental devices to traction/compression-based mandibular advancement appliances in an effort to minimize complications and improve efficacy. Recently, Vezina et al. [2] reported on the long-term efficacy (>2 years) of traction/compression-based mandibular advancement appliances with regular medical visits, questionnaires, repeat cephalometrics, and polygraphic recordings in more than 150 moderately overweight, non-obese subjects with baseline mean AASM apnea–hypopnea index (AHI) of 30.5 per hour. An AHI ≤5 per hour was achieved in 28% and 24% of subjects with traction and compression devices, respectively. Partial efficacy was noted in about 59% of subjects with a mean AHI of 14 per hour. Pain was the primary reason for discontinuing therapy. In short, long-term follow-up studies such as Vezina et al. are needed to make mandibular advancement appliances a cornerstone of obstructive sleep apnea (OSA) therapy.

Surgical treatment of the maxilla and mandible offers a more definitive therapy for OSA. Distraction osteogenesis is not routinely done in the treatment of OSA in teenager and young adults [3]. However, a review of all internationally published cases of maxilla–mandibular advancement with several meta-analyses showed that this approach can be curative in teenagers and young adults with proper selection and technique [4]. Age is a very important consideration as success rate clearly drops after 40 years of age. Maxilla advancement less than 11 mm has also been shown to hinder the response [4]. Interestingly, a Taiwanese analysis using 3D-CT suggests that successful advancements may impact the position of the anterior spine, a finding that has not been replicated to date [5]. The risks and complications of distraction osteogenesis are not negligible. The risks and benefit of genioglossus advancement surgery in the treatment of OSA is still debated. Uvulopalatopharyngoplasty is usually a poor surgery. Resection of the uvula leads to scarring and retraction of tissue within 2 to 3 years post surgery and disrupts mechano-receptors that help maintain airway patency during inspiration. Therefore, pharyngoplasty with adenotonsillectomy and, if indicated, nasal septum repair stands as the best soft tissue surgery, while mandibular–maxillary advancement surgery remains the most efficacious surgical option. The combination of the best soft tissue surgery and the bi-bloc mandibular advancement device might lead to better outcomes than soft-tissue surgery and geniotubercle advancement. The bi-bloc mandibular advancement device alone may provide similar efficacy compared to the geniotubercle advancement but with less risk and complications [6, 7]. OSA management clearly requires both otolaryngologists and orthodontists. Training programs specifically tailored to maxilla–mandibular advancement surgery for OSA treatment are needed. Orthodontists are starting to become aware of the importance of recognizing and treating OSA, but collaboration between otolayrngologists and orthodontists will lead to the best treatment outcomes.

Although dentists and orthodontia recognize the importance of evaluating and treating OSA, they have yet to realize how

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well-positioned they are for the prevention of sleep-disordered breathing (SDB). Preliminary data from the Stomatology and Orthodontia Department of the University of Bordeaux (France) (personal communication) suggest that the snoring–mouth breathing, pre-pubertal child is at greater risk of developing cavities than non-mouth breathers. Why does a child become a mouth breather and what are the anatomical facial risks factors that lead to mouth-breathing and SDB? Clearly, there are families with a predisposition to OSA since familial clusters of OSA has been well documented. Certain cranio-facial features predispose individuals to develop SDB. However, not all family members develop abnormal breathing during sleep. Huang et al. published an abstract (Huang YS, Lin CH, Guilleminault C. "Homozygotic twins discordant for sleep-disordered breathing." *Proceeding of the International Pediatric Sleep Association Congress* (Rome, Italy) 2010.) reporting 12 homozygotic twins that were discordant for SDB (n=6) or at least with very different severities at polysomnographic and 3D-CT scan analyses (n=6). This finding indicates that environment plays an important role in the development of SDB. Therefore, manipulation of environmental factors may decrease the development of OSA. There is a need to better define these environmental factors and predict those at risk for the development of OSA so that orthodontists and dentists can both treat and prevent OSA.

There is a continuous interaction between mouth breathing, tongue position, and tonsillar enlargement [8, 9]. Enlarged tonsils displace the position of the tongue, promoting tongue thrust, and mouth breathing. Swedish researchers have shown that mouth breathing leads to continuous micro-trauma of the tonsillar tissues leading to an inflammatory reaction and tonsillar enlargement. Therefore, in addition to tonsillectomy, we should also consider prescribing an anti-leukotriene agent [10, 11]. Harvold et al. [12] demonstrated in monkeys and, subsequently, many orthodontists in children that impaired nasal breathing affects tongue position, promotes mouth breathing, and, most importantly, influences maxilla/mandibular development. A deviated septum, early onset of allergy symptoms, and asymmetric external nasal valves are examples of anatomic features and physiologic processes that may lead to abnormal nasal resistance and, ultimately, mouth breathing. It is unclear which process initiates this interaction between mouth breathing, tongue position, and tonsillar enlargement. Therefore, a simultaneous treatment approach that addresses tonsillar enlargement with tonsillectomy, anti-leukotriene treatment, tongue/mandibular position with oral appliances/distraction osteogenesis, and nasal surgery, if indicated, must become the standard of care in children with SDB.

One unresolved issue is the in utero development of the hard palate and both maxilla. As shown in one of the articles in this issue of *Sleep and Breathing* [13], premature individuals may have a very narrow hard palate putting them at risk for SDB. A narrow maxilla leads to increased nasal resistance of which promotes mouth breathing and subsequently SDB. The presence of this very specific pattern indicates the important role of in utero life in the development of normal nasal breathing. An on-going follow-up study of premature infants during the first 2 years of life is evaluating the effect of widening the hard palate on nasal breathing [14]. Preliminary data have shown that premature infants are much more likely to present at 1 to 2 years of age with a high and narrow hard palate, abnormal nasal resistance, and mouth breathing, which all promote the development of an abnormally long, inferior third of the face. However, not every premature infant follows this exact path. If nothing is done in these premature infants, SDB and OSA will develop although at different ages. Orthodontists and pediatric dentists are the specialists that can recognize these risk factors and bring them to parental attention. The question is what can be done?

In pediatric OSA, a concept has progressively emerged that evaluates the size of tissues relative to the external limits of the upper airway rather than just the absolute size of the soft tissues. Tonsils are not necessarily enlarged as in infectious tonsils but, nonetheless, are occupying space and, therefore, increasing resistance. Using principles of fluid dynamics in adults, Powell et al. (Powell N, Guilleminault C. "Abnormal pharyngeal airflow in obstructive sleep apnea using computational fluid dynamics: Feasibility study." *Proceeding of the 9th World Congress on Sleep Apnea* (Seoul, Korea) 2009) have shown that shear forces are greatly increased in narrow, irregular upper airways. This may play a role in the progressive impairment of upper airway mechano and other receptors involved in the coordination of the diaphragm and upper airway muscle contractions [14, 15]. There are no recommended therapies for SDB at such an early age. Anna Schaft in Israel reported performing tonsillectomy at 6 months of age without detrimental consequences in infants with very narrow upper airways. In our own clinical practice, we have performed tonsillectomy at 10–12 months of age with clear responses in severe cases. Again, the tonsils are only a small part of a larger problem: a narrow upper airway.

The question that remains is what to do after tonsillectomy at this early age. In our collaborative project with Taiwan in evaluating and treating SDB in premature infants, simple mouth devices are being used to apply pressure on the hard palate during sleep but results are not currently available. Often times, in the presence of persistent SDB, nasal CPAP has been used as a bridge to more definitive, orthodontic therapy. Pirelli and her school [15] have shown that we can perform rapid-maxillary distraction to open the narrow hard palate to decrease nasal resistance and promote better facial growth. Even still, this approach cannot be applied until 3.5 to 4 years of age at the earliest due to several factors such as the width of the mandible and position of the teeth serving as support for distraction. Distraction can be repeated 2–3 years later. To avoid undue stress to teeth, Monteyrol and Darque (personal communication) placed small implants into the hard palate to serve as anchors for distraction [2, 16]. As discussed above, tonsillar enlargement appears to be related in part to the continuous trauma and inflammation related to mouth breathing; therefore, an anti-leukotriene agent should be prescribed in addition to tonsillectomy [10, 11]. However, these approaches are only possible once a child is older. Furthermore, regular follow-up of these “early” (4+ years) orthodontic interventions has shown that this is not always enough to obtain normal nasal breathing during sleep.

There is also an absolute need to send the child to a muscle reeducation specialist to reposition the tongue [17]. The child and parents should perform daily tongue exercises at least 30 min daily; otherwise, mouth breathing during sleep will persist. Reeducation of tongue muscles and exercising the upper airway muscles has been going on for years in countries such as Brazil [17] or the University of Liege (Belgium), where it is not only applied to children but also to adults with documented improvement by polysomnography. Unfortunately, this therapy is only possible once the child reaches an age when he/she can cooperate and perform the exercises.

One can see that the role of dentists and orthodontists has become very important and will continue to grow even further in the years to come [18]. This issue of *Sleep and Breathing* discusses only a few problems faced by specialists. Hopefully, it will incite more investigation and research into the pathophysiology, evaluation, treatment, and ultimately the prevention of the development of adult OSA.

Conflict of interest None of the author has conflict of interest.

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