Impact of nasal airway obstruction on dentofacial development and sleep disturbances in children: preliminary notes

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Respiratory disorders in the upper respiratory tract during sleep are most often part of a continuous pathological process of long standing. Schematically, three clinical syndromes with increasing severity are described: breathing with the mouth open, snoring and sleep apneal hypopnea syndrome. Obstructive sleep apnea syndrome (OSAS) is a subtle, but severe sleep disorder of early childhood. It is often difficult to detect and may have long-term consequences, including failure to thrive, behavioral disturbances, developmental delay, and cor pulmonale.[1] These conditions always include a functional maxillofacial perturbation, which may be associated with a constitutional or acquired morphological disorder.

Pediatric dentists must be aware of the problems connected with mouth breathing and OSAS (obstructive sleep apnea syndrome) in children as any delay in diagnosis and treatment may cause prolonged morbidity. They also have a role in the diagnosis and co-management of these patients because the signs and symptoms may be recognizable in the dental practice.

Besides the medical approach itself, the treatment sometimes is surgical, always orthopedic: the earlier it is initiated, the more effective, simple and unrestraining it is. The aim of this work is to focus attention on the early diagnosis and prevention of these pathologies. Diagnostic guidelines will be illustrated.
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INTRODUCTION

Establishing a cause-effect relationship between nasorespiratory function and dentofacial development is not easy. Many studies have demonstrated how airway obstruction may have an important influence on facial form and is often associated with a dolichocephalic pattern of growth (the so called "long-face syndrome").

In 1872, Tomes[2] described the "adenoid face" and the concept that facial form can be influenced by enlarged adenoids became accepted as hypothesis. Tomes' view were supported by many leading orthodontists including Todd and Broadbent[3] and Balyeat and Bowen.[4]

Angle[5] included airway obstruction as an important etiological factor in malocclusion. Moss[6] in developing the functional matrix theory presented a logical rationale for the findings seen in nasally obstructed patients. His view is that bone responds to the influences of function and adjoining soft tissue explained the narrow palate and long face seen in mouth breathers. Nasal obstruction and mouth breathing influence facial growth, which may further lead to difficulty in breathing while asleep.

Nowadays many researchers have proved the existence of connections between nasorespiratory disorders and sleep disturbances. Respiratory disorders in the upper respiratory tract during sleep are most often part of a continuous pathological process of long standing. Schematically, three clinical syndromes with increasing severity are described: breathing with the mouth open, snoring and the sleep apnea / hypopnea syndrome. The obstructive sleep apnea syndrome (OSAS) is regarded as a common complication of nasal obstruction and is often difficult to detect. It is a subtle, but severe sleep disorder of early childhood and occurs in 1.6% - 3.4% of children between 6 months and 6 years of age. OSAS is characterized by repetitive breathing stops (for ten seconds or more) and oxyhemoglobin desaturations during sleep. Related hypoxia results in surges in blood pressure and brief arousals from sleep.

OSAS is now recognized as a common cause of excessive daytime sleepiness and can contribute to premature cardio-vascular disease. It may have long-term consequences, including failure to thrive, behavioral

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Table 1. Diagnostic guidelines

1. Medical history (daytime sleepiness, hypertension, type 2 diabetes mellitus, behavioral disturbances, developmental delay)
2. Respiratory history
3. Family history of allergy
4. Breast-feeding, bottle sucking or pacifier sucking in the first months of life
5. Sleep patterns (total sleep time, open-mouth sleeping, snoring, sleep apnea)
6. Extraoral examination: Long Face Syndrome (facial posture, lip posture, nose morphology, hyponasal speech, oral breathing)
7. Intraoral examination: open-bites, cross-bites, marginal gengivitis, macroglossia
8. Diagnostic tests: panoramic radiograph, latero-lateral and postero-anterior cephalometric projections, PSG
9. Neurological and otolaryngological consultation

disturbances, developmental delay, and cor pulmonale.[1] It can also cause renal symptoms even in people with normal renal function, including nocturnal polyuria, nocturia and enuresis. Other symptoms include daytime drowsiness, poor school performance, enuresis, poor appetite and/or weight gain, dysphagia, vomiting, chronic mouth breathing, frequent otitis media, sinusitis, sore throat and choking.

Pediatric dentists must be aware of problems connected with mouth breathing and OSAS in children: they play an important role in the diagnosis and co-management of these patients because signs and symptoms may be recognizable in the dental practice. Any delay in diagnosis and treatment may cause prolonged morbidity.

Besides the medical approach itself, the treatment sometimes is surgical, always orthopedic: the earlier it is initiated, the more effective, simple and non restraining it will be. The aim of this work is to focus attention on the early diagnosis and prevention of these pathologies. Diagnostic guidelines will be illustrated.

DIAGNOSTIC GUIDELINES (see Table 1)

The respiratory history and the examination of the patient at the first visit are very important. The history of frequent colds or "sinus" and a family history of allergy and nonfebrile pharyngitis, are very important. Common findings in the medical history include daytime sleepiness, snoring, hypertension and type 2 diabetes mellitus. The parents should be asked about the sleep patterns of the child: an open mouth while sleeping may be a supporting sign. Besides, any incidence of snoring or sleep apnea is very important; the inclusion of a query concerning the presence of snoring in a questionnaire should always be present as well as questions concerning the habits of the first months of life (particularly as far as breast-feeding, bottle sucking or pacifier sucking are concerned). An increase in total sleep time, nonspecific behavioral difficulties, hyperactivity, irritability, bed-wetting and morning

Figure 1. Frontal photograph: a lip-apart posture and a "gummy smile" are evident.

headaches should always be investigated. Sleep apnea and a nonfebrile pharyngitis are often seen in mouth breathers.

The extraoral examination often puts in evidence a Long Face Syndrome with hyponasal speech, retrognathia due to a post-rotational growth of the mandible, a lip-apart posture and a "gummy smile" (Figure 1). The facial posture should be noticed as well as if the lips are closed while breathing (Figures 2-3). Long-standing nasal airway obstruction can lead to a disuse atrophy of the lateral alar cartilage: the result is slit-like external nares with a narrow nose (Figures 4- 5).

From a functional point of view, the child should be asked to seal his lips and report if it is difficult for him to breathe through the nose. One nostril can be collapsed and the question repeated, followed by the other nostril.

The intraoral examination often puts in evidence an anterior open-bite; either unilateral or bilateral posterior cross-bites may be present (Figure 6). A characteristic marginal gingivitis (Figure 7) around the maxillary anterior teeth can be observed.

Macroglossia and oral breathing, when present, may represent risky factors for OSAS and must always be carefully evaluated.

A panoramic radiograph, a latero-lateral and a postero-anterior cephalometric projection are to be performed in patients suspected for mouth breathing disorders: a cephalometric tracing will put in evidence situations at risk for sleep distrurbances such as retrognathia, post-rotational growth of the mandible, and

Figures 2-3. Notice the facial posture as well as the closure of the lips while breathing.

Figures 4-5. Long-standing nasal airway obstruction can lead to a disuse atrophy of the lateral alar cartilage: the result is slit-like external nares with a narrow nose.

asymmetries responsible of the narrowing of the maxilla (Figures 8 to 10). Neurological and otolaryngological consultation and a polysomnographic test are highly recommended in patients at risk.

DISCUSSION

Sleep disordered breathing, although not only related to oral breathing, is a common, but subtle disorder of early childhood. The most severe form, OSAS, is often difficult to detect and may have long-term consequences. At special risk are individuals with macroglossia, retrognathia[7] and buccal breathing.[8]

There are sound medical reasons for nasal respiration. The nasal airways filters, heats, and humidifies the air in preparation for entry into the bronchi and lungs. Besides these obvious reasons, the functional nasal airway creates a proper amount of nasal resistance so that the diaphragm and intercostal muscles must perform

Figure 6. Either unilateral or bilateral posterior cross-bites may be present: the narrowing of the maxilla may represent a risky factor for sleep disturbances.

Figure 7. A characteristic marginal gingivitis around the maxillary anterior teeth can be observed.

Figure 8. Lateral photograph: a marked retrognathia is clinically evident.

work to create the negative pressure to promote airflow into the lungs.

With oral respiration, this important resistance is lacking and poor pulmonary compliance is seen. Also, appropriate nasal resistance results in higher airflow speed promoting oxygen reaching the peripheral alveoli of the lungs.[9] Mouth breathing results in lower velocity of the incoming air. Oral breathing causes changes in pulmonary mechanics as well as in the pressure of arterial blood gases. In response to increased nasal obstruction oro-nasal breathing occurs. The level of oro-nasal partitioning maintains an adequate level of respiratory resistance. When upper airway resistance is increased limitation of flow occurs. Snoring indicates a mild degree of reduced airflow. Sleep apnea occurs when upstream pressure falls below a critical pressure.[10]

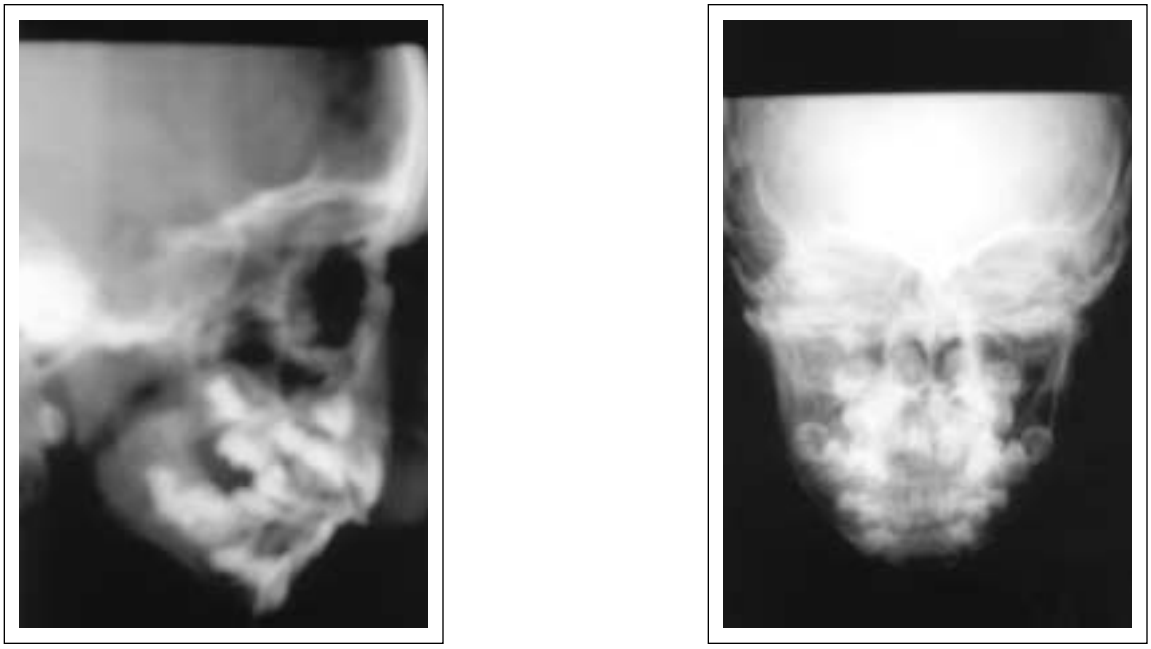
Nasal airway obstruction is promptly followed by the establishment of an oral airway. These patients often have lip-apart posture, even if it should not be considered pathognomonic for nasal obstruction. Patients with lip-apart posture can be nasal respirators, obtaining a posterior seal between the tongue and soft palate. Longstanding nasal airway obstruction can also lead to a disuse atrophy of the lateral alar cartilage, the result is slit-like external nares with a narrow nose.[11]

Oral breathing and the lowering of the mandible associated with it, alters the force system acting on the maxillo-mandibular complex. As the mandible is dropped, the hyoid bone also lowers, removing the tongue from the palatal vault. This clinical situation is often associated with a post-rotation growth of the mandible and a consequent anterior open-bite. The weight of the buccinator muscles is no longer opposed by the mass of the tongue and unequal forces are created.

Frequently unilateral or bilateral posterior cross-bites are seen in nasally obstructed patients as the maxilla narrows. Posterior tooth eruption and vertical alveolar development may occur. Moller[12] Sassouni[13] and Epker[14] agree that the forces generated by the muscles of mastication between the maxilla and the mandible are partly responsible for the spatial relationship of those bones.

On smiling, many patients reveal large amounts of gingiva producing a "gummy smile". A characteristic marginal gingivitis around the maxillary anterior teeth can be seen because of the drying effect of mouth breathing.

Nowadays more attention must be paid to the mechanical orthopedic benefits of breastfeeding in preventing the narrowing and the hypofunction or the respiratory tract. It favors a proper development of the jaws forming the gateway to the human airway and surely deserves more attention and investigations. Recent research have



Figures 9-10. The latero-lateral and the postero-anterior cephalometric projection cephalometric tracng put in evidence situations at risk for sleep disturbances such as retrognathia, post-rotational growth of the mandible and asymmetries responsible of the narrowing of the maxilla.

focused the attention on the action of breast suckling in aiding proper development of the jaws: suckling forces generally act to spread and form wide dental arches and promote good swallow muscle tone which aids proper jaw and airway growth. In this way they promote physiological formation of oral structures surrounding the airway. From this point of view, breast-feeding should be reevaluated as it affects orofacial anatomy and physiology at our respiratory system gateway, during the most important craniofacial formative period.

Bottle and pacifier sucking, on the other hand, deforms, constricts and places backwards forces on oral structures, which then act to deform jaws and collapse airways. Breast-fed babies are less likely to develop malocclusion - high pre-maxilla, abnormal alveolar ridges and palate, postrior cross-bite(s)- and allergies.[15]

The exact prevalence of sleep-disordered breathing in children is unknown, but there is a familial predisposition to it. The first series of children with obstructive sleep apnoea syndrome (OSAS) was reported in 1976. Later it became apparent that children may have breathing disorders during sleep without frank apnoea or 'hypopnoeas'. This pattern could be detected by measuring the oroesophageal pressure. This led to the concept of sleep-disordered breathing as a spectrum that combines obstructive sleep apnoea syndrome and the upper airway resistance syndrome. Studies that do not take into account this spectrum may misclassify symptomatic patients as 'primary snorers.[16]

A retrospective study[17] performed in California on 45 randomly selected patients out of a group of 345 discharged with a diagnosis of OSA, uncovered a significant number of patients, who were experiencing prolonged and discomforting symptoms owing to previously undiagnosed obstructive sleep apnea (OSA). Analysis revealed that all patients experienced severe and discomforting symptoms with all describing severe or moderate snoring.

Other symptoms included chronic mouth breathing (84%), frequent otitis media (64%), sinusitis (56%), sore throat (51%), choking (47%), and daytime drowsiness (42%); poor school performance, enuresis, poor appetite and/or weight gain, dysphagia, and vomiting were also referred. Symptoms began at a mean age of approximately 2 years ("birth"-9 years), and the mean period of time between the development of significant symptoms and OSA was 3.3 years (6 months-13 years).

Another study performed in Japan[18] revealed how the clinical findings related to sleeping and the duration of sleeping, snoring was the most frequently referred (100%), while the mean duration of sleep, was 9.9 $\pm$1-1.0 hours. Of the clinical findings hyponasal speech (74%) and oral breathing (89%) were the most frequently observed.

Respiratory disorders may cause a functional maxillofacial perturbation, which may be associated to a constitutional or acquired morphological disorder. Nowadays the medical and dental professions must be aware of the key-role played by breastfeeding in preventing sleep apnea. Recent research have focused the attention on the action of breast suckling in aiding proper development of the jaws forming the gateway to the human airway during a very rapid period of infant jaw growth. In fact the largest increment of

growth occurs during the first year of life: in the five first months in fact, the weight of the child doubles, which will never occur again in a similar span of time. This explains why positive forces are important to proper growth and development in this period of time. According to some authors[19] exclusive breastfeeding should be advocated for at least six months.

By 12 months of age, unimpeded, the maxilla increases markedly in size, and the anterior part of the mandible containing the deciduous teeth more or less attains it a adult size.[20] Rhythmic elevation and lowering of the jaw provides sequential changes in tongue positions coordinated with suckling contractions to stimulate growth.[21] The forces of suckling actively act on the jaw like orthopedic appliance to induce forward and lateral jaw and airway growth, early on.[22]

In the first three years, the height doubles, which never occurs in the entire lifetime. By the age of four, the craniofacial skeleton has reached 60% of the adult size; by the age of twelve, 90% of facial growth has already occurred.[23]

The age of 12 is the age when many orthodontists begin treatment, but to wait until 90% of a deformity is established before instituting treatment is not consistent with a preventative attitude. Since successful treatment of anteroposterior and vertical discrepancies is linked to growth changes, it suggests that interceptive measures should be initiated far earlier than is conventionally done. Prevention of such human illness as apnea, otitis media, nocturnal enuresis, diabetes, hearing and coronary disease begins at infancy thanks to the impact of infant feeding on development and deformation of oral structures.

CONCLUSION

Pediatric dentists play an important role in the diagnosis and co-management of patients with sleep apnea/ hypopnea syndrome because the signs and symptoms may be recognizable in the dental practice. Besides the medical approach itself, the treatment sometimes is surgical, always orthopedic: the earlier it is initiated, the more effective, simple and non restraining it is. After the confirmation of the diagnosis by a physician, pediatric dentists and orthodontists can participate in the management of the disorder by using functional oral appliances that advance the mandible during sleep and enlarge the retroglossal space by anterior displacement of the tongue, improving so respiratory function, particularly at night. Cooperation with otolaryngologists and neurologists is highly recommended during growth to monitor these patients.

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