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An Unreported Risk in the Use of Home Nasal Continuous Positive Airway Pressure and Home Nasal Ventilation in Children

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in the antigen presenting cell affect the differentiation of the T-helper cell Th1/Th2 cytokine response.¹²

Improvement in GSH status could result in augmented lung function through several mechanisms. Within lung epithelial cells, augmented GSH may block the activation of nuclear factor κ B by tumor necrosis factor- α ,^{13–15} and so limit the production and release of proinflammatory cytokines. Augmented intracellular GSH may reduce the need to recycle GSH from the lung lining fluid, and thus maintain extracellular levels.¹⁶ Alternatively, increased intracellular GSH levels may lead to extracellular transport to buttress lung lining levels. In the lung lining fluid, augmented GSH may prevent oxidative damage to antiproteases.^{17,18} Improvement in skeletal muscle function due to augmented GSH stores⁷ may also partially account for our results, as the baseline FEV₁/FVC ratio did not change between times 7 and 8 (66% and 62%, respectively).

The ELF GSH pool has been the target of direct administration of nebulized GSH, although success has been limited by GSH-induced bronchospasm.⁵ Trials of systemic N-acetyl cysteine, acting as both a cysteine donor and an ROS scavenger, for the treatment of chronic obstructive airway disease have met with limited success, because of N-acetyl cysteine toxicity and limited clinical effect.^{2,19}

The relationship between whole blood GSH, lung epithelial cell GSH levels, ELF GSH, and peripheral blood GSH-Px activity is poorly defined. There are several possible mechanisms by which GSH could improve obstructive airway disease, either via immunologic modulation or by improving antioxidant defenses. More work needs to be done to further define the specific abnormalities of antioxidant function, as well as the relative contribution of such abnormalities to the pathophysiology observed in obstructive airway disease. Nevertheless, the modulation of GSH and antioxidant defenses in obstructive airway disease (and many other diseases) represents an intriguing potential modality for anti-inflammatory therapy.

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An Unreported Risk in the Use of Home Nasal Continuous Positive Airway Pressure and Home Nasal Ventilation in Children*

Mid-Face Hypoplasia

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We report the case of a 15-year-old boy with obstructive sleep apnea and obesity who was treated since the age of 5 with nasal continuous positive airway pressure. Due to the long-term use of a nasal mask, the child developed a mid-face hypoplasia. Chronic use of a nasal mask for home ventilation in children should always be associated with regular evaluations of maxillomandibular growth.

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Key words: apnea; children; complication; craniofacial; growth; nasal continuous positive airway pressure; risk; sleep apnea

Abbreviations: CPAP = continuous positive airway pressure; OSA = obstructive sleep apnea

Nasal continuous positive airway pressure (CPAP) has been widely used as a home treatment in adults since a good response to treatment was initially reported in 1981.¹ We have shown that nasal CPAP can be used without difficulties in children² and in infants.³ Several large studies have confirmed that CPAP therapy is safe and clinically effective in adults⁴ and in children,^{5,6} with only minor side effects, such as nasal symptoms and symptoms related to poor mask fit (air leak and skin irritation). Clinical observations over time, however, have led to new questions. The question of long-term compliance has been studied using CPAP devices that measure frequency of use.^{7,8} Not surprisingly, as in any chronic illness, compliance with treatment was shown to be variable. Another issue that has not been investigated is the possible impact of long-term use of a nasal mask on craniofacial structures. We report here a case of mid-face hypoplasia in a child secondary to long-term nasal CPAP therapy.

CASE REPORT

A 15-year-old African-American boy with obstructive sleep apnea (OSA) and morbid obesity was referred for evaluation to assess the present CPAP level. The patient was the product of a normal birth without evidence of any craniofacial or developmental anomalies. He has had a history of significant weight gain since 3 years of age. At age five, obesity and OSA at polygraphic recording were diagnosed. At that time, his height was normal for his age and he had normal craniofacial features. He had a nasal CPAP titration, and nasal CPAP therapy was begun via face mask, set at 7.5 cm H₂O.

The patient was followed by his pediatrician. At age eight, his CPAP pressure was adjusted to 9 cm H₂O. He was not seen again in a sleep clinic until he was 15 years old, primarily because he lived far from any sleep clinic, lacked clinical symptoms, and had limited health insurance coverage. When he was seen again at the sleep clinic, his nasal CPAP was still set at 9 cm H₂O, as recommended 7 years earlier. Although several attempts had been made at weight loss, including enrollment in weight loss programs, he had continued to gain weight. His OSA, however, had been well controlled by CPAP therapy, and he reported that he had been a nightly CPAP user for the past 10 years without problems.

On examination, the patient was found to be morbidly obese (body mass index, 44.1 kg/m²). Although he had no history of craniofacial syndromes, the mid-face region appeared severely depressed, especially in the perinasal region. When the child was seen by a maxillofacial specialist, the maxilla was recognized as being hypoplastic. The patient has a skeletal class III relationship. Lateral cephalometric radiograph confirmed the clinical findings (Fig 1). Fitting of the CPAP mask matched the most severely affected perinasal region. Airway evaluation demonstrated adenotonsillar hypertrophy. The patient subsequently underwent nocturnal polysomnographic recording and retitration of his CPAP with good results. The respiratory disturbance index was 1.2 events/h of sleep, with oxygen saturation nadir at 90% at a CPAP pressure of 9 cm H₂O. He elected to continue CPAP therapy. He has also enrolled in a weight loss program. The mid-face hypoplasia has not yet been addressed.



FIGURE 1. Lateral cephalometric radiograph.

DISCUSSION

To the best of our knowledge, this is the first reported case of mid-face hypoplasia secondary to prolonged nasal CPAP therapy by face mask. It is well known that craniofacial development occurs primarily during the prepubertal years. By 4 years of age, about 60% of the adult face is developed. At age five, when nasal CPAP treatment was initiated in this child, facial development was normal. Due to the positive pressure exerted by the face mask, a counteracting force with a headgear is necessary to maintain the mask in position and prevent leaks. Long-term application of the tight-fitting headgear and face mask has resulted in the retardation of facial skeletal development in this growing child. Indeed, the application of headgear and face mask to manipulate facial growth has been applied in orthodontics for years, and craniofacial modifications are well documented in orthodontic literature.⁹⁻¹¹

It is difficult to estimate the duration of CPAP therapy that could lead to adverse effects on facial growth, but it is logical to assume that it correlates directly with the length of therapy as well as the amount of pressure applied. What may be even more important, however, is the timing of therapy as it relates to the timing of facial growth. Since approximately 90% of the facial growth is completed by

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age 12, it seems reasonable to suggest that long-term use of a nasal mask (whether it be nasal CPAP, nasal bilevel, or nasal intermittent positive pressure ventilation) prior to age 12 may affect the development of the facial skeleton. Whether long-term use of a nasal mask can have a similar impact in adults is unknown. It is possible that there may be some impact on the vascular bed irrigating the upper region, particularly in the elderly, but our information is only anecdotal.

The majority of children with OSA have adenotonsillar hypertrophy and are successfully treated with adenoidectomy and tonsillectomy.¹² Nasal CPAP is primarily used in children with craniofacial anomalies, trisomy 21, obesity, neuromuscular weakness, surgical failures, or as an interim treatment prior to surgery.²⁻⁶ Because most children do not require long-term CPAP or nasal ventilation therapy,¹³ and treatment beyond 4 to 6 years is uncommon,^{2,3,5,6} retardation of mid-face development may be less likely to occur. In addition, children who require long-term nasal ventilation therapy may have preexisting craniofacial deformity, which makes the diagnosis difficult. It must be cautioned, however, that the prolonged application of an orthopedic force (CPAP headgear/face mask unit) on the malleable and developing facial skeleton can result in deleterious effects on growth and may worsen an already existing problem. Individuals at risk should have regular (at least yearly) maxillomandibular evaluations, and more data should be accumulated on problems associated with long-term use of any type of face mask in children, adults, and the elderly.

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