MOUTH BREATHING AND ITS RELATIONSHIP TO SOME ORAL AND MEDICAL CONDITIONS

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ABSTRACT

Excessive mouth breathing may be related to different oral and medical conditions. **Objective**: To explore the possible mechanisms involved in the relationship between mouth breathing and some oral and medical conditions. **Methods:** A review of the literature was performed by using PubMed, Scielo and Hinari. Relevant and updated articles were selected. **Results:** Mouth breathing has been linked to oral conditions such as dry mouth and lips, dental caries, periodontal disease, secondary halitosis, craniofacial deformity, malocclusion, abnormal swallowing, and to medical conditions such as obstructive sleep apnea, asthma**,** compromised airway, altered body posture, heart diseases and poor performance. Among the mechanisms that may explain that relationship are chronic hypoxemia with hypercapnia, increased water and energy lose, decreased growth hormone release, inflammatory and oxidative mediators release, large load on the upper back and neck muscles, deformity in the airway passage and craniofacial deformities. **Conclusions**: Mechanisms underpinning the relationship between mouth breathing and oral and medical diseases vary from biochemical, physiological and immunological deficiencies to anatomical effects. More studies are needed to explore a causal relationship.

Key words: Mouth breathing, dental caries, periodontal disease, halitosis, craniofacial, malocclusion, OSA, performance, posture, asthma.

INTRODUCTION

Mouth breathing refers to the state of inhaling and exhaling through the mouth. The literature describes the prevalence of mouth breathing as ranging from 5 to 75% of children tested [1, 2].

Excessive mouth breathing is problematic because of different disturbances. The air is not filtered and warmed as much as when inhaled through the nose, as it bypasses the nasal canal and paranasal sinuses, and dries out the mouth, among other mechanisms. Mouth breathing is often associated with congestion, obstruction, or other abnormalities of the upper respiratory tract as well as other oral and medical conditions [3-12].

One requirement to establish that certain condition can act as a risk factor for diseases is to determine the theoretical plausibility of the mutual relationship. However, despite the published data about mouth breathing as a risk factor for certain oral and medical conditions, the mechanisms underlying these complex relationships are not fully understood.

These reasons motivated this review of the literature with the objective to explore the possible mechanisms involved in the relationship between mouth breathing and some oral and medical conditions.

METHODS

A review of the literature was performed through PubMed, Hinari and Scielo From a total of 8871 articles, 46 original and review articles were selected according to relevance and mainly from the last 5 years. The following key words were used: mouth breathing, dental caries, periodontal disease, halitosis, craniofacial, malocclusion, OSA, performance, posture, asthma.

RESULTS

1. Causes of mouth breathing

Mouth breathing is characterized by inhalation and exhalation through the mouth. Different causes have been cited. The main are: chronic allergies, tonsil and adenoid hypertrophy, nasal polyps, deviated nasal septum, constricted upper airways, thumb sucking, excessive pacifier use or insufficient suckling as an infant [13].

Some authors have considered that the two main causes of mouth breathing in children are firstly allergic rhinitis and secondly adenoid hypertrophy [3]. Allergic rhinitis may play a key role in mouth breathing due to its high prevalence. This stresses the importance of allergologic investigation in mouth-breathers, to establish specific treatments that may reduce morbidity in these patients [14].

2. Consequences of mouth breathing

Due to the complex interconnections involved, some times it is difficult to establish the cause-effect relationship between two factors. That is why some factors which may appear as causes in the previous item, will be posed next also as consequences. It is probably the expression of mutual interaction and positive feed back mechanisms involved.

2.1 General mechanisms for disturbances on mouth breathing

There are different general mechanisms which may explain the consequences of mouth breathing. They are mainly composed of biochemical, physiological, immunological and anatomical disturbances which has been attributed to mouth breathing.

Among the biochemical and physiological disorders are the lower oxygen absorption (chronic hypoxemia), increased CO_2 concentration (hypercapnia), and its related changes in the acid-base balance, towards respiratory acidosis. Also, there is increased water and energy loss, and changes in salivary profile. It has been shown that healthy subjects, experience a 42% increase in net water loss when they switch the breathing mode from nasal to oral expiration during tidal breathing. The authors considered that increased water and energy loss by oral breathing could be a contributing factor to the symptoms seen in patients suffering from nasal obstruction [15].

Also a decreased nocturnal growth hormone (GH) release has been reported. It has been considered that snore at night and struggle for air interferes with growth hormone production in some way [16].

Inflammatory and oxidative mediators release has also been link to mouth breathing, however it is not clear if they are the result of mouth breathing, atopy, other related disturbances or the complex interactions among then. The oxidant nitric oxide (NO) is produced by the action of NO synthase (NOS) on L-arginine in different cell types and found in air exhaled by humans. Most of the exhaled NO is derived from the upper airways and increases in patients with untreated asthma and allergic rhinitis, diseases which exhibit mutual interactions with mouth breathing. The induction of iNOS in patients with allergic rhinitis increases nasal NO which in turn produces the symptoms of nasal obstruction and rhinorrhea, contributing to mouth breathing [17].

With respect to the immune system lowered response has been described which is linked to poor health. It has been stated that nasal breathing produces a tissue hormone that regulates normal blood circulation. It also filters, warms and moisturizes the air. The lack of oxygen in mouth breathers is considered to weaken the immune system [16].

Anatomical effects of mouth breathing are the result of the adaptation of the growing tissues to the abnormal breathing profile. They include among others, large load on the upper back and neck muscles and deformity in the airway passage which are involved in postural disturbances and obstructive sleep apnea. As the jaw in mouth breathers is positioned too far back, along with the tongue, the upper airway is constricted. Enlarged tonsils and adenoids due to chronic allergies may be the primary cause for mouth breathing; however mouth breathing will also cause a further increase in tonsil size, constricting the airway and posing obstacles to nasal breathing. The open mouth will also cause a decreased contractile efficiency of the upper airway muscles affecting nasal breathing [10]. Also dentofacial structures' growing is affected leading to altered profile and malocclusion, among others [7, 8, 18, 19].

3.2 Oral conditions

3.2.1 Dry mouth and lips

The appropriate humidity of the mouth is guaranteed by saliva and any factor that reduces body fluids will reduce salivary output. In mouth breathers, there is a water loss produced mainly through evaporation. So, the decreased resting salivary flow rate could be not high enough to counteract the evaporation effect (estimated up to 0.21 mL/min) of mouth exhalation and this imbalance will lead to dry mouth and lips. This has serious consequences with a declining in gustatory sensitivity, impaired swallowing activity and protective function of saliva, among others [20, 21].

3.2.2 Dental caries

Saliva has many important functions. Among then are self-cleaning of the mouth, buffering and clearing acids, acquired pellicle formation, antimicrobial actions, and provision of ions for remineralization of demineralized enamel. It protects the teeth from organic acids produced by bacteria which cause dental caries, and the extrinsic and intrinsic acids that initiate dental erosion. The depressed resting salivary flow is associated with lower plaque pH, increased numbers of lactobacilli and candida species, and greater caries risk. This could have serious consequences for caries activity, and will also increase the risk of tooth loss via dental erosion [20, 21].

As mouth breathing causes water loss it is a potential factor which could contribute to oral dryness. Some studies have failed to find associations between mouth breathing and caries risk or salivary patterns. For example, Koga-Ito et. al. found no differences in caries risk between treated and untreated children with mouth breathing syndrome, although the level of IgG antibodies to *S. mutans* (cariogenic bacteria) was higher in the treated group [22]. Another study did not find differences in flow rates or buffering capacities of resting and stimulated saliva between mouth- or nose-breathers adolescents aged 10-19 years [23]. However, Al-Awadi et. al. found lower salivary flow rate among males patients 18-22 years old with mouth breathing associated with nasal obstruction in comparison to nose breathers. Mouth breathing was also associated with lower salivary pH, higher plaque index and increased salivary mutans streptococci counts [5]. Other studies also report association between mouth breathing and dental caries [24, 25].

3.2.3 Periodontal disease

The mouth breathing is also considered as one of the predisposing factors for initiation of periodontal disease and/or its progression. The anterior dental open bite produced by chronic mouth breathing is associated with high incidence of periodontal disease and high risk of loosing the anterior teeth in early ages. This causes the absence of anterior guidance which also predisposes the patients for temporomandibular disorders. The precise mechanisms are not fully understood, but probable causes are gingival surface dehydration, decreased epithelial resistance to bacterial plaques, and lack of salivary auto-cleaning [25-29].

3.2.4 Halitosis

Halitosis is a condition characterized by altered halitus in an unpleasant manner for both the affected individual and those interacting around. The majority of halitosis cases are secondary and associated with oral problems. In particular, the changes in salivary flow patterns and water imbalance leading to surface drying of the mucosa induced by mouth breathing may be related to halitosis. A reduction in salivary flow avoids its protective functions in the cleaning of the mouth and antibacterial actions, causing a shift in the bacterial flora in the mouth. So, the growth of proteolytic bacteria produce volatile odoriferous sulfur compounds [6, 15].

Conditions which may appear as consequences of mouth breathing such as dental caries and periodontal disease can also contribute to halitosis. Also chronic allergies and infections of the nose and throat related to mouth breathing can give rise to bad breath [30].

3.2.5 Craneofacial deformity and malocclusion

While craneofacial structures are growing, they adapt to the different breathing pattern in mouth breathers. The changes in facial musculature affect the dental arches and positioning of the teeth, linked to structural disturbances in the lips, tongue, palate and mandible with subsequent face deformity [6]. Also, mouth breathing decreases chewing activity, reducing the vertical effect on the posterior teeth, which can affect negatively their vertical position, leading to malocclusion [31, 32].

The altered fashion is characterized by: long faces with an increase in the anterior lower facial height, constricted maxillary arches, increased palatal height with reduction of the palatal surface area and volume, tooth crowding, a narrowed nasal airway passage, and enlarged nostrils. The lower jaw remains too far behind in its growth with increased mandibular plane angle and gonial angle, producing a small chin, dental malocclusion (Class II), hypotonic lower lips, hypertonic upper lips, protrusion of the anterior teeth and nasal prominence, with unfavorable profile [1,7,8,18,19,33].

It has been also hypothesized that decreased mandibular growth in adenoid face children is due to the abnormal nocturnal secretion of growth hormone and its mediators, which is normalized following adenotonsillectomy with acceleration in the growth of the mandible and change in its growth direction. It has been explained by more intensive endochondral bone formation in the condylar cartilage and/or by appositional bone growth in the lower border of the mandible [16].

In children 3-6 year old, subjected to mouth breathing rehabilitation which included adenotonsillectomy, a significant normalization in the mandibular growth direction, a decrease in the mandible inclination, and an increase in the posterior facial height, was accomplished after 28 months, although occlusal features experienced no change [34,35].

3.2.6 Abnormal swallowing

It has been shown in patients 11-14 year old, that mouth breathing is related to abnormal swallowing [9]. Mouth breathing is often accompanied by anterior tongue thrust, instead of a lip closure, in order to create the anterior seal necessary for the initiation of physiological deglutition [36].

Nasal breathing is the most effective way of tongue control during swallowing. In normal swallowing, the tongue pressures the roof of the mouth creating peristaltic waves which send the food bolus down the esophagus and into the stomach, with partial closure of the epiglottis. Mouth breathers disturbances (infant swallowing, tongue thrust, facial rictus when swallowing) cause abnormal peristaltic activity which lead to the swallowing of a lot of air. In the long term, the concomitant stomach secretions reflux can cause loss of elasticity of the throat, which consequently will collapse, as it can be found in moderate and severe obstructive sleep apnea. In severe apnea, the entire pharynx could collapse [6].

The abnormal swallowing profile of mouth breathers can also cause aspiration of foreign particles and fluid into the lungs, which would also enhance pneumonia, emphysema, and other chronic obstructive pulmonary diseases. This illustrates the complex interactions and links that are established between different disturbances associated to mouth breathing.

3.3 Medical conditions

3.3.1 Altered head, neck and body posture

The unphysiological process of breathing through the mouth produces a reflex forward head posture. This puts a large load on the upper back and neck muscles, which if sustained, will cause permanent posture changes, such as abnormal curvatures in the cervical and thoracic vertebrae, an altered shoulder posture, which in turn will affect hips, knees and feet. In adults, jaw joint dysfunction can be derived from postural disturbances [10, 37, 38].

Open-mouth breathing is also associated with reduction of the retropalatal and retroglossal areas, lengthening of the pharynx and shortening of the distance between the mandible and hyoid bone in the upper airway [6, 7, 38, 39].

3.3.2. Obstructive sleep apnea (OSA)

The decreased contractile efficiency of the upper airway muscles in mouth breathers may lead to increased collapsibility of the upper airways. In newborns, it has been related to Sudden Infant Death Syndrome and in children, this is manifested as snoring, bed-wetting, poor quality of sleep and obesity. In adults, OSA is linked to death. Snoring is a milder version of sleep apnea and an expression of a blocked airway. Treating nasal obstruction in mouth-breathing patients with OSA results in better sleep, as well as a modest improvement in OSA severity. This points to the role of nasal obstruction and mouth breathing in the pathology of OSA (11). Chronic hypoxemia, which is present in this patients during the night, has also been implicated in the genesis of ventilatory depression by affecting the synthesis and activity of several neurotransmitters and by altering the central and peripheral function of chemoreceptors. Chronic adaptation of these chemoreceptors to hypoxemia and hypercapnia has been reported to result from recurrent apnea. A new, increasingly higher point of regulation for CO_2 occurs during the course of the disease [15, 39].

OSA can bring as consequence other diseases such as cardiovascular disease and stroke, lung dysfunction, obesity, high blood pressure and diabetes mellitus. There is a lot of evidence linking obstructive sleep apnea syndrome with atherogenic processes, cardiovascular mortality, and vehicle and workplace accidents, so an increasing severity of the condition should be associated with increased mortality. Systemic inflammation has also being linked to OSA and its consequences. It has been reported the presence of subepithelial oedema, inflammatory cell infiltration, inflammatory and oxidative mediators in the tissues of the upper ways, nasal lavage fluid, sputum or serum, which positively correlated with the severity of OSA in many cases. Recurrent vibration in the upper airway of children with OSA has been suggested to promote such inflammatory changes in the tonsillar tissue and upper airway mucosa [40, 41] (Figure 1).

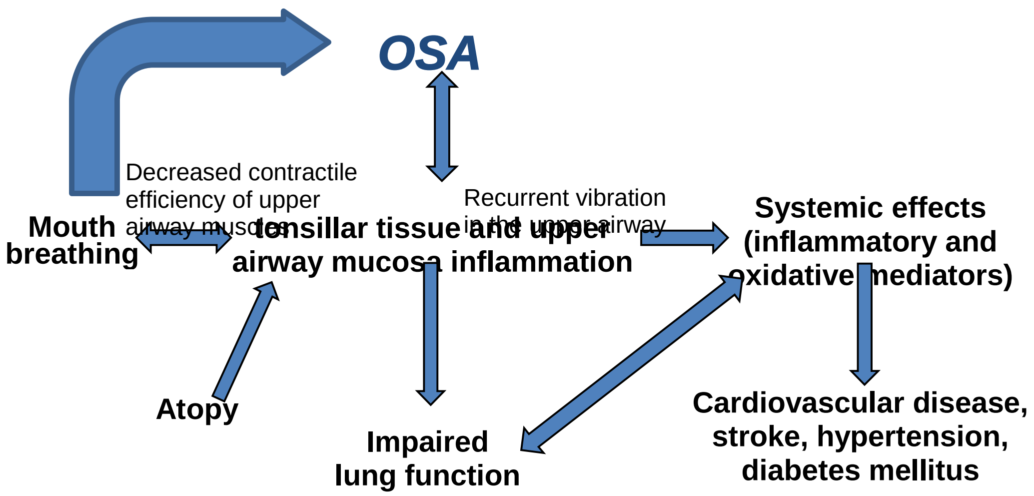

Figura 1. Possible interrelationships between mouth breathing, atopy, tonsillar and upper airway inflammation, obstructive sleep apnea (OSA) and other systemic effects.

3.3.3 Poor physical and learning performance

The same lack of oxygen and other hormonal factors make mouth breather children tend to be overweight, tired, and not perform well at school. Physically they are not athletic. Also mouth breathers show cognitive impairment as well as attention deficit hyperactive disorder (memory, concentration, attention, learning disability, low perception and sensorimotor integration); while surgical treatment which restores nasal breathing benefits also the learning abilities. It may be linked to sleep disorders as it has been shown that children with excessive daytime sleepiness appear to have almost 10 times the risk of learning difficulties [11, 42-44].

It has also been suggested that breathing through the mouth instead of the nose can adversely affect brain function. Hypertrophic pharyngeal and palatine tonsils in mouth breather children is associated to apnea and nocturnal hypoxemia, with the degree of systemic involvement directly related to the degree of tonsil hypertrophy [43].

It has been considered that mouth breathing associated alterations in the central nervous system may be caused by the change in the acid-base balance, with the resultant respiratory acidosis. This affects the activity of ATP-sensitive potassium channels, which play a crucial role in the function of the central nervous system [45].

Sano et al. showed that brain hemodynamic responses in the prefrontal cortex is different when adult individuals change from nasal to mouth breathing, with an increased oxygen load in the prefrontal cortex in mouth breathing. This has been interpreted as a way for the human body to maintain homeostasis over the changes in respiratory frequency and tidal volume triggered by mouth breathing. Although another explanation is that the increased oxygen load in the prefrontal cortex is the result of the voluntary input necessary for breathing through the nonpreferred mouth route [42].

3.3.4 Asthma

A strong connection has been found between mouth breathing and asthma. Enforced oral breathing causes a decrease in lung function in mild asthmatic subjects at rest, initiating asthma symptoms in some. So, oral breathing may play a role in the pathogenesis of acute asthma exacerbations [12]. The nose and not the mouth should be used for breathing as the nose has better air conditioning capacity. When air is inhaled through the mouth it may dry and cool the respiratory mucosa, which can lead to bronchoconstriction in sensitive patients with asthma [46].

In mouth breathers air is not filtered in the nose so the lungs may be exposed to higher concentrations of inhaled, ambient particles. Also enhanced perception of nasal loading may trigger increased oral breathing in asthmatics, potentially enhancing exposure to nonconditioned inhaled gas and contributing to the occurrence and/or severity of bronchoconstrictive exacerbations [12]. As the site of upper airway obstruction in asthmatic children appears to be the epipharynx, the adenoids may play a key-role. So adenoiditis could be a common cause of both mouth breathing and asthma. In a multivariate analysis, atopy was significantly associated with the presence of asthma [46,14]. The excessive release of oxygen free radicals as NO by the activation of iNOS in the upper airways has been reported in patients with untreated asthma and allergic rhinitis, which is counteracted by inhalation of steroids [17].

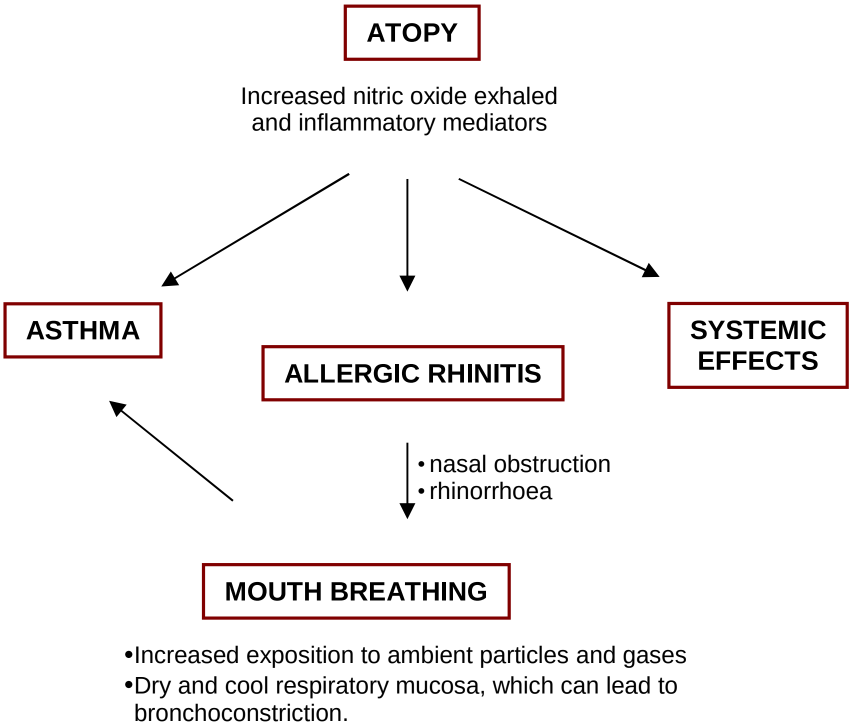

Figure 2. Possible relationships between atopy, allergic rhinitis and mouth breathing in asthma pathogenesis.

Recently, it has been also evidenced that childhood mouth-breathing yields consequences for the ventilatory function at adult age, with lower respiratory muscle strength and functional exercise capacity, which could also adversely influence asthma episodes (4).

CONCLUSIONS

Mechanisms underpinning the relationship between mouth breathing and oral and medical diseases vary from biochemical, physiological and immunological deficiencies to anatomical effects. Although the relationship between mouth breathing and oral and medical conditions seems well established, it is difficult to assess in all cases from the literature data, the cause-effect link. More studies are needed to explore a causal relationship.

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