

Changes in the palatal dimensions of mouth breathing children caused by nasal obstruction

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Abstract. During children's growth and development, the breathing process plays an important role in craniofacial growth, especially of the palate. Nose breathing can stimulate the lateral growth of the maxilla, thus making the palate flat. Disturbances in nose breathing caused by nasal obstruction such as allergic rhinitis, adenoid hypertrophy, rhinosinusitis, nasal polyps, and obstructive sleep apnea can lead to a mouth breathing habit in children. This habit can cause palatal dimension changes such as a narrow V-shaped maxillary arch and a high palatal vault. This study analyzed the relationship between the mouth breathing habit in children who have nasal obstruction and palatal dimension changes. A cross-sectional descriptive study was conducted with a consecutive sampling method on children 7-18 years old with a history of allergic rhinitis, adenoid hypertrophy, rhinosinusitis, nasal polyps, and obstructive sleep apnea in the Pediatric Respiriology and Pediatric Immunology Allergy Outpatient Clinic Kiara Maternal and Child Health Center at Cipto Mangunkusumo Hospital in Jakarta. The palatal dimensions were measured by the height and transversal width of the hard palate of castings of each child's upper dental arch using vernier calipers. Palatal dimension changes were found in children with a mouth breathing habit due to nasal obstruction.

1. Introduction

The hard palate is the bony structure that forms the division between the oral cavity and nasal cavity [1]. According to the functional matrix theory developed by Moss, the breathing process plays an important role in craniofacial growth. This theory is based on nasal breathing's influence on the development of the craniofacial structure, contributing to harmonious growth by interacting with mastication and swallowing. Nasal breathing can stimulate the lateral growth of the maxilla, thus making the palate flat, affecting the breathing [2,3]. Any factors that promote obstruction in the upper airway lead to a change from nose breathing to mouth breathing. In children, the causes of nasal obstruction are rhinitis allergy, adenoid hypertrophy, nasal polyps, rhinosinusitis, and obstructive sleep apnea syndrome [2,4].

Mouth breathing may influence myofunctional aspects, body posture, craniofacial morphology, and dental occlusion. Mouth breathing also produces alterations in hard palate morphology, such as a narrow V-shaped maxillary arch and a high palatal vault. Many studies have shown that there is a relationship between mouth breathing and a high palatal vault [2,5]. Based on this, the aim of this study was to analyze the relationship between mouth breathing caused by nasal obstruction and palatal dimensions.

2. Materials and Methods



For this study, ethical approval was obtained from the Ethical Committee of the Faculty of Dentistry at the University of Indonesia and informed consent was obtained from each subject's parents before inclusion. A cross-sectional descriptive study was conducted with a consecutive sampling method during September-October 2016 in the Pediatric Respiriology and Pediatric Immunology Allergy Outpatient Clinic Kiara Maternal and Child Health Center at Cipto Mangunkusumo Hospital in Jakarta. The exclusion criteria were: a non-nutritive sucking habit for more than 3 years, a history of speech language pathology, a history of orthodontic treatment, signs of neurological impairment and/or syndrome, and craniofacial malformation. The inclusion criteria were: children 7-18 years old that had already been diagnosed with rhinitis allergy, adenoid hypertrophy, nasal polyps, rhinosinusitis, or obstructive sleep apnea. The inclusion criteria were obtained with a questionnaire.

The measures of the hard palate were obtained by creating a mold of the upper jaw using putty elastomeric impression material. This process was conducted in a room with natural and artificial lighting. The children remained seated with their hips, knees, and ankles positioned at 90 degrees and their heads positioned in Frankfort plane. The measurement of the hard palate was performed by obtaining the palatal height index, which shows a proximate relationship between the height and the width of the palate. This index was obtained by measuring the width and the depth of the hard palate in the maxillary first molar region with vernier calipers, which have an accuracy of 0.01 mm.

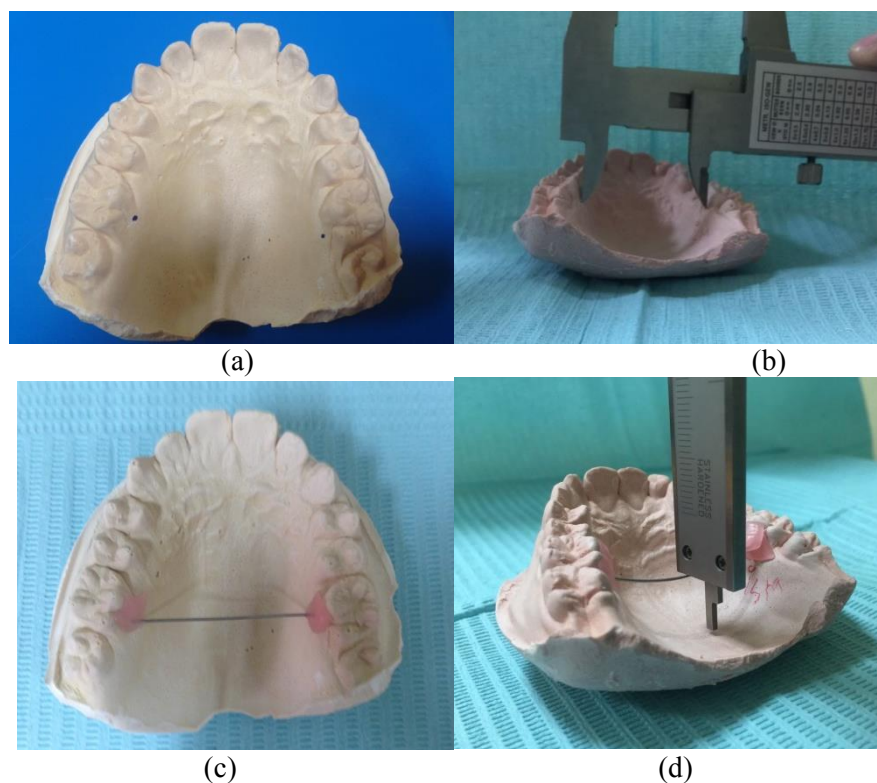


Figure 1. (a) Reference points on a study casting, (b) Molar width, (c) Stainless steel wire that measures the height of the hard palate, (d) Molar depth

To measure the width of the hard palate, reference points were marked on each casting in the maxillary first molars region at the union of the gingival margin and palatal groove (Figure 1a). The molar width is the transversal distance in millimeters between the points of the gingival margin maxillary first molars (Figure 1b). To measure the height of the hard palate, 0.05 mm stainless steel wire was cut into a length corresponding to the width of the palate and fixed with dental wax between the reference points (Figure 1c). Molar depth is the vertical measurement in millimeters from the

palatal middle line to the stainless steel wire that links the reference points (Figure 1d). The measurement of the palatal dimensions is: Index of Palatal Height = (Palatal height x 100)/Palatal width. The depth of the palate was classified into three categories: low palate values ≤ 27.9 mm, medium palate values 28 mm-39.9 mm, and high palate values ≥ 40 mm. The measurement of the width and height of each hard palate was performed by a single researcher. Each measurement was repeated three times.

3. Results and Discussion

3.1 Results

During this study's time period of September-October 2016, we found 7 mouth breathing children caused by nasal obstruction. In these 7 subjects, 72% of the nasal obstructions were caused by rhinitis allergy, 14% caused by rhinosinusitis, and 14% caused by adenoid hypertrophy. None of the subjects had nasal polyps or obstructive sleep apnea syndrome (OSAS). The distribution of gender was that 86% were boys and 14% were girls. The distribution by age was that 63% were 14 years old, 29% were 7 years old, and 14% were 12 and 16 years old. In this study, we divided the time span of mouth breathing into three categories: 1-2 years, 2-3 years, and >3 years. The distribution of mouth breathing by time span was that 43% had been mouth breathing for 1-2 years, 14% for 2-3 years, and 43% for >3 years.

The evaluation of the depth of the hard palate based on the palatal height index showed that the mouth breathing children had high palates in 57% of the cases, 14% had medium palates, and 29% had low palates. This study showed that the depth of the hard palate may be related to the time span of mouth breathing. Of the 7 subjects, 29% had a low palate when the time span of mouth breathing was 1-2 years, 14% had a medium palate when the time span of mouth breathing was 2-3 years, and 57% had a high palate when the time span of mouth breathing was >3 years.

3.2 Discussion

Several factors influence craniofacial growth and development, including genetic and environmental factors. Nasal breathing is a stimulus for harmonious craniofacial growth and development. The presence of mouth breathing in children may result in changes to the facial skeleton as well as to hard palate morphology [4,5]. The etiology of mouth breathing in children is largely from rhinitis allergy: 72%, followed by adenoid hypertrophy and rhinosinusitis: 14%. Surprisingly, we did not find mouth breathing children with nasal polyps or obstructive sleep apnea syndrome. This is different from the previous study, which found that the most common cause of mouth breathing in children is adenoid hypertrophy. Mouth breathing occurs when there is a mechanical hindrance to the airflow passage through the upper airway, commonly because of adenoid hypertrophy [2].

In this study, mouth breathing had the highest frequency in boys rather than in girls (86% and 14%, respectively). The highest percentage of mouth breathing occurred in children 14 years old and it had been happening for 2-3 years or >3 years. The mouth breathing children had narrow and V-shaped maxillary arches and high palatal vaults [2]. In the literature review, many studies were found on measuring palate dimensions in mouth breathing children. Palate dimensions are measured by the height and transversal width of the hard palate from castings of the upper dental arch. In this study, we used the palatal height index. The depth of the hard palate was classified into three categories: low palate, medium palate, and high palate [6].

In this study, of the 7 subjects, 57% had a high palate. According to Berwig *et al.* [7], mouth breathing children have a mean that is significantly higher in the depth of the hard palate in the molar region. It can be concluded that respiratory mode has an influence on palate dimensions. Mouth breathing induces morphological changes in the hard palate because the absence of negative pressure in the nasal cavity prevents the lowering of the palate and the actions of other face bones and muscles that assist in compressing the outer maxillary arch, so the growth is more pronounced vertically [6]. In this study, of the 7 subjects, 29% had a low palate when the time span of mouth breathing was 1-2 years, 14% had a medium palate when the time span of mouth breathing was 2-3 years, and 57% had a

high palate when the time span of mouth breathing was >3 years. This shows that the depth of the hard palate may be related to the time span of mouth breathing. But it requires further study.

4. Conclusion

It can be concluded that respiratory mode can influence the vertical and transverse dimensions of the hard palate. Mouth breathing children tend to have a narrow V-shaped maxillary arch and a high palate vault. In our study, we found a frequency of 57% of high palate in mouth breathing children. And the most common etiology of mouth breathing children in this study was rhinitis allergy.

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