

# Position and orientation of hyoid bone in mouth breathing children: a cephalometric study

## Abstract

**Introduction:** The importance of the hyoid bone is associated with its unique anatomical position. The hyoid bone is the only bone in the facial skeleton that attaches to other bones only with the help of muscles.

**Aim:** The aim of this article is to make a cephalometric analysis of the craniofacial anatomy and position of the hyoid bone in children with mixed dentition who have difficult nasal breathing, habitual mouth breathing and a control group of nasal breathing children.

**Materials and methods:** A total of 120 lateral cephalograms of children with mixed dentition were analyzed. The examined X-rays were divided into three groups: 50 lateral cephalograms of children with difficult nasal breathing; 18 lateral cephalograms of children with a habitual mouth breathing and 52 lateral cephalograms of nasal breathing children. To determine the position of the hyoid bone we used the method of Bibby and Preston.<sup>1</sup>

**Results:** When comparing the type of the hyoid triangle we found the presence of a statistically significant difference ( $\chi^2 = 24.97$ ;  $p < 0.001$ ). In 84% of the children with nasal breathing difficulties there is a negative hyoid triangle and in only 16.00% a positive hyoid triangle. In the nasal breathing children, the positive triangle occurs in 84.60% of cases. In children with habitual mouth breathing the distribution is almost even. A significant difference was found when comparing the height of the negative triangle in children with nasal breathing difficulties and nasal breathing children ( $t = 6.06$ ;  $p < 0.001$ ).

**Conclusion:** In mouth breathing children there is a lower and posterior position of the hyoid bone compared to nasal breathing children. The negative triangle is characteristic for children, who have difficult nasal breathing, whereas the positive triangle is specific for nasal breathing children.

**Keywords:** nasal breathing difficulties, habitual mouth breathing, hyoid bone

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Zornitsa Vulcheva, Hristina Arnautska

Faculty of Dental medicine, Orthodontic Department, Medical University-Varna, Bulgaria, Tel +359883320971, Email zornitsa.vulcheva@gmail.com

**Correspondence:** Zornitsa Vulcheva, Faculty of Dental medicine, Orthodontic Department, Medical University-Varna, Bulgaria, Tel +359883320971, Email zornitsa.vulcheva@gmail.com

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## Introduction

The importance of the hyoid bone is associated with its unique anatomical position. The hyoid bone is the only bone in the facial skeleton that attaches to other bones only with the help of muscles<sup>1</sup>. The infrahyoid and suprahyoid muscles connect the sublingual bone to various structures such as the tongue, lower jaw, cranium base, the sternum, the thyroid cartilage and the pharynx.<sup>1-3</sup> A change in the position of these structures can change the position of the hyoid bone due to the complex connections between them.<sup>4</sup> The hyoid bone is located in a low position in mouth breathing children. Some authors<sup>5,6</sup> find a relation between its position and increased craniovertebral extension. Others, report stability in the position of the hyoid bone, which is not affected by the change in the position of the head in mouth breathing children.<sup>1,7,8</sup>

**Aim:** The aim of this article is to make a cephalometric analysis of the craniofacial anatomy and position of the hyoid bone in children with mixed dentition who have difficult nasal breathing, habitual mouth breathing and a control group of nasal breathing children.

## Materials and methods

A total of 120 lateral cephalograms of children with mixed dentition were analyzed. The examined X-rays were divided into three groups:

➤ **Clinical group 1** including 50 lateral cephalograms of children with difficult nasal breathing;

➤ **Clinical group 2** including 18 lateral cephalograms of children with a habitual mouth breathing

➤ **Control group** including 52 lateral cephalograms of nasal breathing children.

To determine the position of the hyoid bone we used the method of Bibby and Preston.<sup>1</sup> To make this analysis we used the following reference points proposed by them (Figure 1):

C3 – the point at the most inferior and anterior position on the third cervical vertebrae.

RGn – retrognathion – the most posterior and inferior point on the mandibular symphysis

H – hyoidale – the most anterior and superior point of the body of the hyoid bone. Hy' – hyoid prime – the perpendicular from point H to the mandibular plane

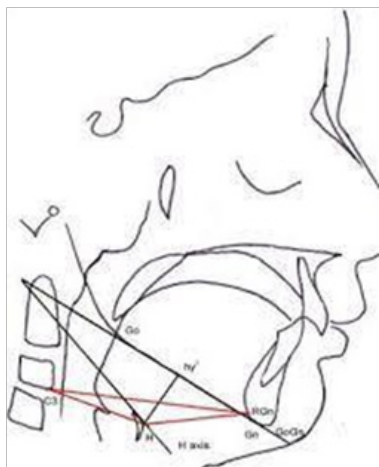
Go – the intersection of the mandibular plane and the ramus of the lower jaw

Gn – the most posterior point of the symphysis Go-Gn – the mandibular plane

H-hy' – perpendicular from point H to the mandibular plane C3-RGn – linear distance from C3 to RGn

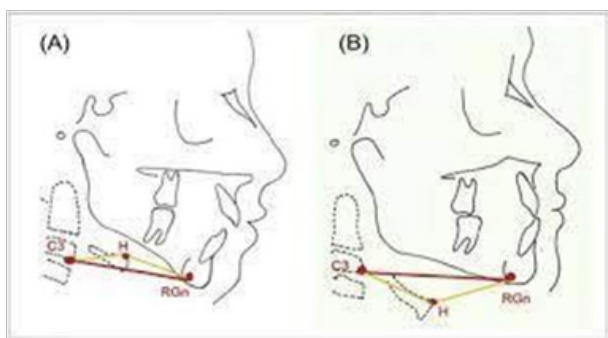
C3-H – linear distance from C3 to H; it gives us information about the antero-posterior position of the hyoid bone.

H-RGn – linear distance from H to RGn; it gives us information about the horizontal position of the hyoid bone.



**Figure 1** Cephalometric method of analysis of the hyoid bone by Bibby and Prestone.<sup>1</sup>

The same authors found average values for the norm for the sides of the hyoid triangle, respectively, as follows: C3-RGn is 67.20 mm, C3-H is 31.76 mm and H- RGn is 36.83 mm. There are two main types of hyoid triangle (Figure 2):



**Figure 2** Types of hyoid triangle: fig.A Negative hyoid triangle, fig.B Positive hyoid triangle.<sup>1</sup>

The negative hyoid triangle is observed in mouth breathing children and is characterized by the hyoid bone, which is positioned above the C3-RGn line. The positive hyoid triangle is observed in nasal breathing children and is characterized by the hyoid bone, which is positioned below the C3-RGn line.

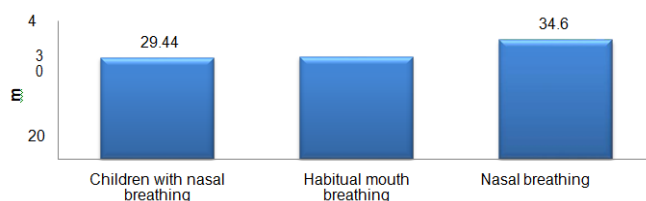
## Results

The average cephalometric measures for the H-C3 side are showed in Figure 3. The average mean is the largest in the group of nasal breathing children (34.65 mm) and the smallest in children with nasal breathing difficulties (29.44 mm).

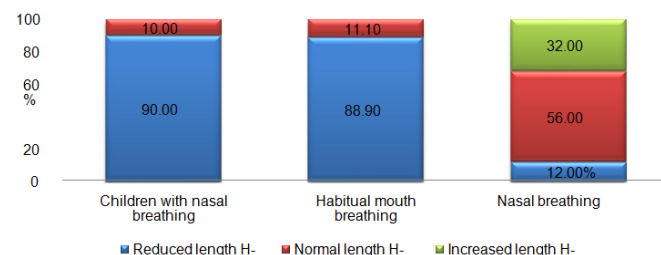
In the group with nasal breathing difficulties, 90.00% of the children have a reduced length on this side. In children with habitual mouth breathing, reduced side length occurs in 88.90%. In nasal breathing children the cases with normal length of this side of the hyoid triangle prevail (56.00%), followed by those with values above the normal - 32.00% (Figure 4).

The average cephalometric measures for the H-RGn side are showed in Figure 5. In the mouth breathing children in the two clinical groups

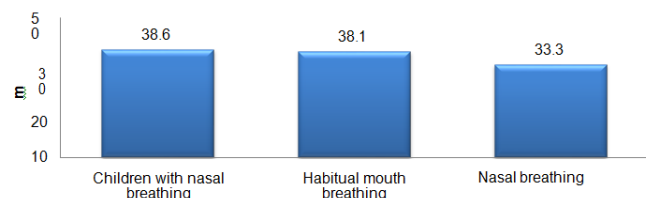
the values are close to one another and are higher than the norm. The nasal breathing children has the lowest values of this side of the hyoid triangle (33.36 mm).



**Figure 3** Comparison of the average value of H-C3.

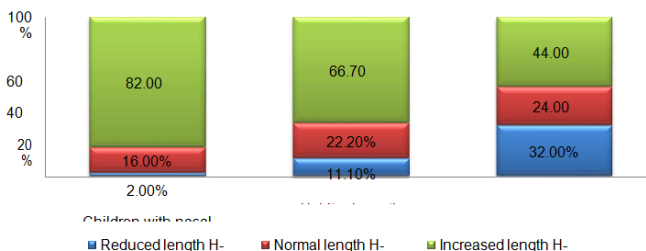


**Figure 4** Percentage distribution of the side H-C3 according to the norm.



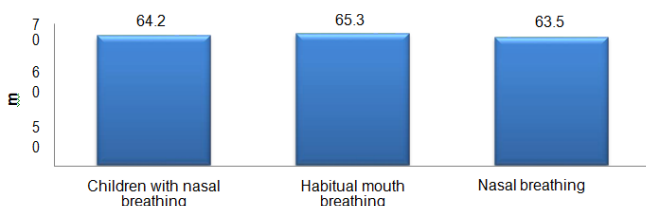
**Figure 5** Comparison of the average value of H-RGn.

When comparing the percentage distribution of the H-RGn side of the hyoid triangle in all studied groups, the values above the norm prevail (Figure 6). This percentage is highest in children with nasal breathing difficulties. We found a statistically significant difference between the three groups of children according to the norm of H-RGn ( $\chi^2 = 21.27$ ;  $p < 0.001$ ).



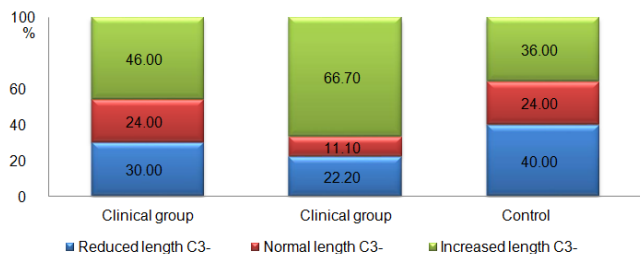
**Figure 6** Percentage distribution of H-RGn side according to the norm.

When comparing the average value of the side C3-RGn, the highest values are reported in children with a habitual mouth breathing, and the lowest in nasal breathing children (Figure 7).



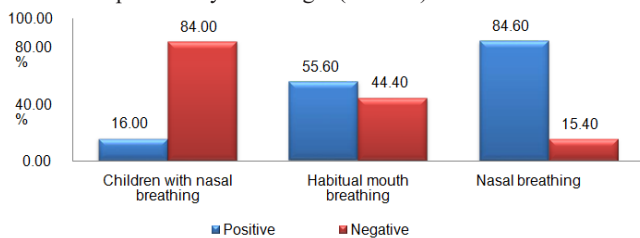
**Figure 7** Comparison of the average value of C3-RGn.

We found that in habitual mouth breathing children the highest percentage (66.70%) of children have increased length on the side C3-RGn. In contrast, in the nasal breathing children have the highest percentage with a shortened side - 40.00%. The results in children with nasal breathing difficulties are between these in the other two study groups (Figure 8).



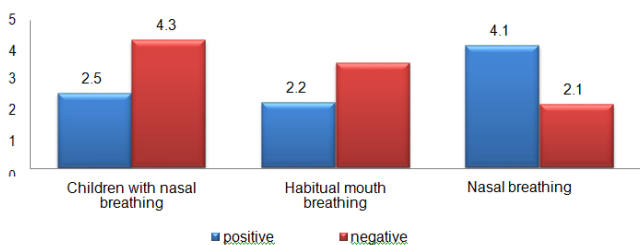
**Figure 8** Percentage distribution of C3-RGn according to the norm.

When comparing the type of the hyoid triangle of the examined children in the three groups, we found the presence of a statistically significant difference ( $\chi^2 = 24.97$ ;  $p < 0.001$ ) (Figure 9). In 84% of the children with nasal breathing difficulties. There is a negative hyoid triangle and in only 16.00% a positive hyoid triangle. In the nasal breathing children, the positive triangle occurs in 84.60% of cases, while the negative in only 15.40%. In children with habitual mouth breathing the distribution is almost even, with a low prevalence of cases with a positive hyoid triangle (55.60%).



**Figure 9** Percentage distribution of children according to the type of hyoid triangle.

A significant difference was found when comparing the height of the negative triangle in children with nasal breathing difficulties and nasal breathing children ( $t = 6.06$ ;  $p < 0.001$ ) (fig.10). The height of the negative triangle in children with nasal breathing difficulties is about 2 times greater than the height of the same in the nasal breathing children (4.35 mm to 2.15 mm, respectively). There was a significant difference ( $t = 3.56$ ;  $p < 0.01$ ) when comparing the average height of the positive triangles in nasal breathing children and those with nasal breathing difficulties.



**Figure 10** Comparison of the average value of the height of the hyoid triangle.

## Discussion

In children with nasal breathing difficulties and habitual mouth breathing, the cases with a negative hyoid triangle predominate, while

in healthy nasal breathing children the positive triangle predominates. Thus, the change in the hyoid position can lead to changes in the size of the pharyngeal pathways and to various clinical consequences.<sup>9-11</sup> Our results show a significant difference in height between the positive and negative hyoid triangle in children with oral and nasal breathing.

McNamara<sup>12</sup> as well as other authors<sup>13,14</sup> confirm that there are significant differences in the vertical position of the hyoid bone in oral and nasal breathing children. The higher the height of the negative and the lower the height of the positive hyoid triangle favor the appearance and development of oral respiration in the two studied groups. Our results show a correspondence between the negative hyoid triangle, its height and the severity of distal occlusion. According to Gray,<sup>15</sup> a change in the position of these structures can change the position of the hyoid bone due to the complex connections between them, which confirms our results.

## Conclusion

In mouth breathing children there is a lower and posterior position of the hyoid bone compared to nasal breathing children. The negative triangle is characteristic for children, who have difficult nasal breathing, whereas the positive triangle is specific for nasal breathing children. Children, who have a harmful habit both are equally as common.

## Acknowledgments

None.

## Conflicts of Interest

None.

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