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Study on the Effect of Adenoid Hypertrophy on the Morphological Development of Mandible in Adolescents with Different Vertical Facial Types of Class II Malocclusion

Estudio del Efecto de la Hipertrofia Adenoidea en el Desarrollo Morfológico de la Mandíbula en Adolescentes con Diferentes Tipos de Maloclusión Facial Vertical de Clase II

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SUMMARY: To investigate the effect of adenoid hypertrophy on the morphological development of the mandible in adolescents with different vertical facial types of Class II malocclusion, 104 patients who met the inclusion criteria were selected. Cone Beam Computed Tomography (CBCT) was used to measure the angle and linear parameters before and after treatment, and a total of 23 related parameters were measured in all three-dimensional models using Invivo5.0 software. Independent-samples t-test was conducted to observe whether there was a statistically significant difference between the groups' data, P-values < 0.05 were considered statistically significant. Experimental results confirmed that adenoid hypertrophy had a significant effect on mandibular morphogenesis in Class II malocclusion high angle adolescents (P<0.05) and a lesser effect on mandibular morphogenesis in Class II malocclusion homogeneous adolescents (P>0.05). The differences in the horizontal, coronal and vertical openness of the mandible in relation to the skull were statistically significant (P<0.05) in the hypertrophic hypergoniacal cases compared to the non-hypertrophic Class II malocclusion hypergoniacal cases, while mandibular Angle width GoR-GoL, mandibular volume length Co-Pog, mandibular body length L-a and mandibular branch length L-b, chin height B-Me and chin thickness C-C´ index difference were statistically significant (P<0.05); The differences in the development of mandibular opening relative to the cranium, mandibular length and width, and mandibular ascending length and width were not statistically significant (P>0.05) compared with non-adenoidal hypertrophy in Class II malocclusion homogeneous cases, the difference of chin thickness C-C´ in chin morphology was statistically significant (P < 0.05). This study provides a theoretical basis for the clinical treatment of patients with various skeletal facial types affected by adenoid hypertrophy.

KEY WORDS: Adenoid hypertrophy; Class II malocclusion; Vertical facial types; Mandibular morphology; Cone Beam Computed Tomography.

INTRODUCTION

The occurrence of early malocclusion is influenced by both genetic factors within the family and environmental factors, including abnormal respiratory, chewing, and muscle functions (Maspero *et al*., 2014). Early orthodontic treatment aims to prevent and correct skeletal hypoplasia, dental malocclusion, and unhealthy oral habits (McNamara Jr. & Keim, 2014; Li, 2022). Adenoid hypertrophy with mouth breathing is one of the most common early malocclusion in adolescents. Adenoid hypertrophy results in the narrowing of the upper respiratory tract, alters the positioning of facial muscles and the tongue through neuromuscular feedback, and disrupts the pressure balance between the maxillofacial bones and teeth, ultimately affecting the proper development of the upper and lower jaws (Giuca *et al*., 2008). Patients

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with chronic mouth breathing may also have an "adenoid face". In addition, mouth breathing may be associated with various types of malocclusion. Related studies have demonstrated a high correlation between skeletal Class II malocclusion and patients with adenoid hypertrophy (Linder-Aronson, 1970; O'Ryan *et al*., 1982; Adamidis & Spyropoulos, 1983). Patients with adenoid hypertrophy were observed to experience a compensatory increase in airway airflow, as well as a backward and downward rotation of the mandible, attributed to alterations in breathing patterns (Valera *et al*., 2003). Studies have pointed out that adenoid hypertrophy patients except mandibular plane in clockwise rotation and tilt forward labial teeth, dental arches and narrow front under high increase (Linder-Aronson *et al*., 1993; Osiatuma *et al*., 2015). Clinical data has indicated that patients with different vertical facial types of Class II malocclusion suffering from adenoid hypertrophy exhibit alterations in upper and lower dental arch width. Additionally, there is a correlation between mandibular sagittal growth and this deformity. Early intervention for maxillomandibular deformity can improve airway issues and have significant clinical implications for the development of the upper and lower jaws (Jadhav *et al*., 2020; Mao *et al*., 2021).

In current research on adolescent jaw development with adenoid hypertrophy, most studies utilize X-ray plain film to measure two-dimensional indicators. However, Cone Beam Computer Tomography (CBCT) and three-dimensional reconstruction technology are increasingly being employed in dental clinical examinations due to their superior image quality and exceptional spatial resolution. These technologies allow for high-resolution CT images to be captured from various angles, including sagittal, coronal, and vertical planes, enabling a more comprehensive three-dimensional measurement of the cranial, maxillofacial, and neck regions. This approach aims to minimize errors associated with converting three-dimensional data into two-dimensional measurements.

The impact of adenoid hypertrophy on the morphological development of the mandible in adolescents with different vertical facial types of Class II malocclusion is not fully understood. This study aims to discuss this effect, focusing on calculating measurement index data. This study not only to guide early education on adenoid hypertrophy, also for adenoid hypertrophy of different types vertical facial patients provide theoretical basis for the clinical treatment and intervention measures.

MATERIAL AND METHOD

Quantitative Cervical Vertebral Maturation (QCVM) was used to select the stage III of growth deceleration (QCVM III). A total of 104 patients with skeletal class II malocclusion were collected. The inclusion criteria were as follows: (1) adolescents, QCVM III, Han Chinese; (2) adenoid hypertrophy patients as the experimental group, using A/N > 0.61 diagnostic method to diagnose adenoid hypertrophy; (3) skeletal Class II malocclusion (–ANB≥5°); (4) surface around the basic symmetry, chin point deviation from the median sagittal < 2 mm. This experiment utilized ratio analysis to determine whether an adenoidectomy hypertrophy. Based on the angle between the Frankfurt horizontal plane and the submandibular plane (Fig. 1) and whether the adenoid was hypertrophic or not, 104 patients were divided into different vertical facial types: Class II malocclusion high angle cases with adenoid hypertrophy, Class II malocclusion high angle cases without adenoid hypertrophy, Class II malocclusion homogeneous angle cases with adenoid hypertrophy, Class II malocclusion homogeneous angle cases without adenoid hypertrophy. To enhance the experimental background's credibility and make up for potential omissions, the experimental subjects were scanned using the same CBCT (KAVO 3D eXam Vision) at the Stomatological Hospital of Shanxi Medical University. The CBCT images import Mimics 21.0 for three-dimensional reconstruction, the coordinate system is established, correct the head, the image of medical Digital imaging and communications (Digital imaging and communications in Medicine, Dicom) form the import Invivo5.0 (Anatomage, Inc. SanJose, USA) software image three-dimensional reconstruction (Fig. 2) and fixed-point measurements (Fig. 3). Enter data into SPSS 25.0 statistical analysis software, choose 95 % confidence interval, inspection level of 0.05. Independent sample t test was conducted on each measurement data to determine whether there was statistical difference between the two groups. The data was presented as mean ± standard deviation.

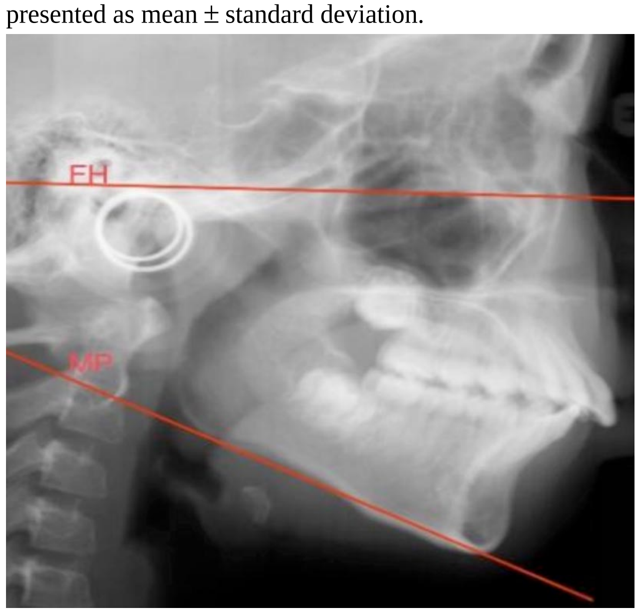

Fig. 1. Schematic representation of the reference plane.

Fig. 2. The final experiment standard model.

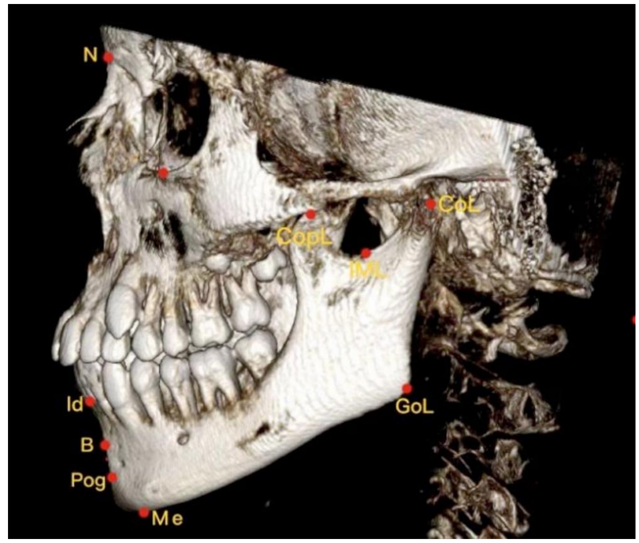

Fig. 3. Schematic representation of the measurement landmarks.

RESULTS

1.Adenoid hypertrophy had a significant effect on mandibular morphogenesis in Class II malocclusion high angle adolescents (P<0.05) and a lesser effect on mandibular morphogenesis in Class II malocclusion homogeneous adolescents (P>0.05).

2.The differences in the horizontal, coronal and vertical openness of the mandible in relation to the skull, such as –GoR-Pog-GoL,–GoR-N-GoL, –Co-Go-Me and –CoL-CoR-GoR/–CoR-CoL-GoL, were statistically significant (P<0.05) in the hypertrophic hypergoniacal cases compared to the non-hypertrophic Class II malocclusion hypergoniacal cases. Suggesting that it would increase the opening of the mandible relative to the skull in hypertrophy of adenoids in hyperangular cases accompanied by adenoid hypertrophy (Table I). While mandibular angle width GoR-GoL, mandibular volume length Co-Pog, mandibular body length L-a and mandibular branch length L-b, which differences

Table I. Comparison of mandibular angle between the high angle experimental group and control group (°).

	Class II malocclusion high angle cases without adenoid hypertrophy	Class II malocclusion high angle cases with adenoid hypertrophy	*P*
<GoR-Pog-GoL	73.5 ± 2.2	78.2 ± 1.2	<.001
<GoR-N-GoL	52.5 ± 3.1	57.9 ± 0.9	.007
<GoR-S-GoL	68.4±1.1	76.9±2.3	.051
<CoR-GoR-Me (R/L)	119.2±4.7	121.9±1.6	.035
<CoR-Pog-CoL	50.5 ± 5.0	50.7 ± 4.6	.906
<Co-IM-Cop (R/L)	112.5±4.2	101.3±3.5	.051
<CoL-CoR-GoR/<CoR-CoL-GoL	98.4±1.9	87.8±3.0	.022

Table II. Comparison of mandibular linear distance between the high angle experimental group and control group (mm).

	Class II malocclusion high angle cases without adenoid hypertrophy	Class II malocclusion high angle cases with adenoid hypertrophy	*P*
CoL-CoR	87.3±16.1	90.0 ± 7.3	.699
GoL-GoR	92.4±4.6	97.3 ± 3.2	.005
Pog-GoLGoR	63.7±2.8	64.7±2.0	.628
Co-Go(R/L)	49.5±4.1	48.6 ± 1.7	.637
Co-Pog(R/L)	106.4±2.1	116.9 ± 1.1	<.001
Go-Pog(R/L)	80.0±3.9	80.9±2.5	.731
Co-Cop(R/L)	37.1 ± 4.3	37.8 ± 1.6	.695
L-a(R/L)	83.2 ± 3.4	87.8 ± 0.4	.020
L-b(R/L)	40.3 ± 2.6	36.2 ± 1.4	.004

were statistically significant (P<0.05), indicating that the trend of mandibular growth and development was that mandibular angle width, mandibular body length and mandibular volume length became larger and mandibular ascending branch length became smaller in the adenoid hypertrophy high angle group patients (Table II). The difference in chin height B-Me and chin thickness C-C´ were statistically significant (P<0.05), indicating an increase in chin height, which is a decrease in chin thickness and mainly posterior chin thickness compared to non-adenoidal hypertrophy in hyperangular cases in adenoidal hypertrophy (Table III).

The differences in the development of mandibular opening relative to the cranium, mandibular length and width, and mandibular ascending length and width were not statistically significant (P>0.05) compared with non-adenoidal hypertrophy in Class II malocclusion homogeneous cases, indicating that adenoidal hypertrophy had less effect on the development of the vertical direction of the mandible and the development of the length and width of the mandible itself in homogeneous cases (Table IV, Table V); The difference in chin thickness C-C´ chin morphology was statistically significant (P<0.05), indicating that a reduction in chin thickness occurred (Table VI).

Table III. Comparison of chin morphology between the high angle experimental group and control group (mm).

	Class II malocclusion high angle cases without adenoid hypertrophy	Class II malocclusion high angle cases with adenoid hypertrophy	*P*
Id-Id'	43.0 ± 3.2	45.9 ± 0.7	.083
B-Me	15.0 ± 1.5	17.2 ± 0.6	.005
C-C'	24.9±2.7	19.6±2.0	.007
C-C'/B-Me	1.6 ± 0.2	1.0 ± 0.1	<.001
B-C	26.7 ± 2.3	22.8 ± 1.2	.273
B-C'	46.9 ± 3.9	25.4 ± 0.6	<.001
B-C/B-C'	0.6 ± 0.0	1.1 ± 0.1	<.001

Table IV. Comparison of mandibular angle between the homogeneous angle experimental group and the control group (°).

	Class II malocclusion homogeneous angle cases without adenoid hypertrophy	Class II malocclusion homogeneous angle cases with adenoid hypertrophy	*P*
<GoR-Pog-GoL	71.7 ± 5.8	72.2 ± 3.3	.849
<GoR-N-GoL	49.1 ± 2.7	52.5 ± 6.0	.279
<GoR-S-GoL	67.0 ± 3.7	66.3 ± 5.5	.821
<CoR-GoR-Me (R/L)	118.6 ± 6.6	116.4 ± 7.3	.604
<CoR-Pog-CoL	52.4 ± 7.9	59.9 ± 5.3	.080
<Co-IM-Cop (R/L)	97.1 ± 7.9	105.9 ± 9.2	.116
<CoL-CoR-GoR/<CoR-CoL-GoL	92.8 ± 13.2	105.4 ± 35.7	.474

Table V. Comparison of mandibular linear distance between the homogeneous angle experimental group and the control group (mm).

	Class II malocclusion homogeneous angle cases without adenoid hypertrophy	Class II malocclusion homogeneous angle cases with adenoid hypertrophy	*P*
CoL-CoR	96.7 ± 16.2	87.5 ± 26.1	.503
GoL-GoR	93.5±3.6	93.7 ±4.1	1.000
Pog-GoLGoR	63.3 ± 8.6	67.3 ± 7.6	.407
Co-Go(R/L)	52.5 ± 4.0	51.3 ± 2.7	.531
Co-Pog(R/L)	112.1 ± 7.7	107.3 ± 5.8	.251
Go-Pog(R/L)	83.6 ± 8.8	83.1 ± 8.1	.923
Co-Cop(R/L)	36.2 ± 6.4	37.5 ± 7.8	.774
L-a(R/L)	88.4 ± 6.3	86.1 ± 4.2	.463
L-b(R/L)	40.3 ± 3.5	42.2 ± 3.8	.408

Table VI. Comparison of chin morphology between the homogeneous angle experimental group and the control group (mm).

	Class II malocclusion homogeneous angle cases without adenoid hypertrophy	Class II malocclusion homogeneous angle cases with adenoid hypertrophy	*P*
Id-Id'	43.4 ± 7.4	44.5 ±3.6	1.000
B-Me	12.0±4.8	14.8 ± 2.1	.106
C-C'	51.1±25.2	24.9 ± 14.2	.043
C-C'/B-Me	3.7±1.9	1.5 ± 0.7	.060
B-C	26.6 ± 5.8	27.8 ± 3.3	.648
B-C'	38.4 ± 19.4	33.2 ± 10.9	.564
B-C/B-C'	0.9 ± 0.5	0.9 ± 0.3	.964

DISCUSSION

The aim of this study is to investigate the effect of adenoid hypertrophy on the morphological development of the mandible in adolescents with different vertical facial types of Class II malocclusion by reconstructing three-dimensional maxillofacial and craniocervical CBCT models. The results showed that the effect of adenoid hypertrophy on mandibular development of high-angle patients was greater than that of homogeneous angle cases. This is consistent with the experimental results of previous studies (Siriwat & Jarabak,1985; Ferrario *et al*., 1999; Nakawaki *et al*., 2016).

Adenoid hypertrophy leads to increased mandibular volume, increased sagittal opening, clockwise rotation, and a shorter ramus length in skeletal Class II malocclusion patients. In addition, this study further found that it could lengthen the middle part of the mandibular body and increase the chin height. It appears one of the possible reasons for this result is due to the mandibular body clockwise, cranial and maxillofacial bone self-adaptive modification (Sperry *et al*.,1977). Compensatory growth in the mandible primarily occurs in the middle part of the mandibular body, resulting in increased length. Simultaneously, there is compensatory counterclockwise rotation of the mentum, leading to an increase in mentum height. The clockwise rotation of the mandible is counterbalanced by the synergistic counterclockwise rotation of the mandibular body and chin, preventing worsening of vertical and sagittal craniomaxillofacial issues. The research results at home and abroad, have shown bone window in osseous II class as a proportion of the wrong micromaxillary deformity is the largest (Yagci *et al*., 2012; Patil *et al*., 2021). These findings are consistent with the results of our study showing a decreasing trend of chin thickness in skeletal Class II malocclusion patients, which are not affected by the vertical skeletal pattern. In the treatment of these patients, the initial step is to control the vertical height of the patient. In clinical practice, stimulating condylar growth and promoting counterclockwise rotation of the mandible can be achieved by inhibiting the elongation of posterior teeth, restricting the vertical development of posterior alveolar bone, and utilizing implant anchorage. In more complex cases, surgical osteotomy may be considered to achieve a more effective therapeutic outcome.

The results of this experimental study show that adenoidal hypertrophy has little impact on the morphological development of the mandible in adolescents with skeletal Class II homogeneous angle type. This result may be caused by the growth of the vertical bone surface type. In the homogeneous growth pattern, the vertical growth of the ramus of the mandible is greater than the sagittal growth of the mandibular body, so that the forward growth trend of the mandible is greater than the clockwise rotational growth trend of the mandible, so it can still show a more normal growth trend. In high-angle growth, the vertical growth of the ramus of the mandible is less than the sagittal growth of the mandibular body, and the mandible shows more of a clockwise rotational growth trend. So the vegetative form in adenoid hypertrophy under the stimulus of high Angle mandibular growth "together to promote" effect, and to all Angle of mandibular growth "antagonism" effect, weakening the impact on the mandibular morphological development.

Chin aesthetics is a crucial aspect of facial aesthetics. Research suggests that a slim oval chin line is perceived as harmonious and attractive in Asian populations. Additionally, protrusion of the soft tissue chin along the zero meridian is commonly viewed as the most appealing. Treatment demand tends to rise significantly when the chin protrudes more than 6mm forward or recedes more than 6 mm backward (Lew *et al*., 1992; Lee *et al*., 2004; Rhee *et al*., 2009; Dong *et al*., 2019). Proper chin curvature can enhance the aesthetic balance of the lower third of the face and create softer facial lines. Patients with a Class II malocclusion and maxillary deformity may experience chin retrusion, aplasia, or a shallow chin labial groove. Scholars have pointed out that the chin contour of children and adolescents with skeletal Class II malocclusion is not as attractive as that of children and adolescents with skeletal Class I malocclusion. After the intervention and treatment of their malocclusion, the chin contour has been significantly improved, and the relationship with the lips and face is more harmonious (Paduano *et al*., 2020).

The development of the chin experiences dynamic changes throughout human life. Treatment interventions can improve the contour, position, and curvature of the chin to varying degrees. This study focuses on chin morphology to provide insights for early facial treatment and intervention in adolescents. However, factors such as muscle strength, detrimental habits, and soft tissue thickness can also influence the growth and development of the chin. Therefore, this study solely examines the osseous anatomical landmarks of the chin and relevant measurements, while excluding soft tissue morphological measurements. Subsequent experimental studies are needed to further explore and enhance the relationship between these two aspects.

YI-LIN P.; CHENG-LIANG Y.; WEN-ZE H.; ER-LING Y.; HEE-MOON, K.; XIU-PING W. & LI BING. Estudio sobre el efecto de la hipertrofia adenoidea en el desarrollo morfológico de la mandíbula en adolescentes con diferentes tipos de maloclusión facial vertical de Clase II. *Int. J. Morphol., 42(6)*:1713-1719, 2024.

RESUMEN: Para investigar el efecto de la hipertrofia adenoidea en el desarrollo morfológico de la mandíbula en adolescentes con diferentes tipos de maloclusión facial vertical de clase II, se seleccionaron 104 pacientes que cumplieron con los criterios de inclusión. Se utilizó la tomografía computarizada de haz cónico (CBCT) para medir los parámetros angulares y lineales antes y después del tratamiento, y se midieron un total de 23 parámetros relacionados en todos los modelos tridimensionales utilizando el software Invivo5.0. Se realizó una prueba t de muestras independientes para observar si había una diferencia estadísticamente significativa entre los datos de los grupos; los valores P<0,05 se consideraron estadísticamente significativos. Los resultados experimentales confirmaron que la hipertrofia adenoidea tuvo un efecto significativo en la morfogénesis mandibular en adolescentes con maloclusión de clase II de ángulo alto (P<0,05) y un efecto menor en la morfogénesis mandibular en adolescentes con maloclusión de clase II homogénea (P>0,05). Las diferencias en la apertura horizontal, coronal y vertical de la mandíbula en relación con el cráneo fueron estadísticamente significativas (P<0,05) en los casos hipergoníacos hipertróficos en comparación con los casos hipergoníacos de maloclusión de Clase II no hipertrófica, mientras que el ancho del ángulo mandibular GoR-GoL, la longitud del volumen mandibular Co-Pog, la longitud del cuerpo mandibular L-a y la longitud de la rama mandibular L-b, la altura del mentón B-Me y la diferencia del índice de grosor del mentón C-C´ fueron estadísticamente significativas (P < 0,05). Las diferencias en el desarrollo de la apertura mandibular en relación con el cráneo, la longitud y el ancho mandibulares y la longitud y el ancho ascendente mandibular no fueron estadísticamente significativas (P > 0,05) en comparación con la hipertrofia no adenoidea en los casos homogéneos de maloclusión de Clase II, la diferencia del grosor del mentón C-C´ en la morfología del mentón fue estadísticamente significativa (P < 0,05). Este estudio proporciona una base teórica para el tratamiento clínico de pacientes con diversos tipos de esqueleto facial afectados por hipertrofia adenoidea.

PALABRAS CLAVE: Hipertrofia adenoidea; Maloclusión de clase II; Tipos faciales verticales; Morfología mandibular; Tomografía computarizada de haz cónico.

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