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The effects of different vertical growth on facial morphology in class II cases

Sınıf II vakalarda farklı dik yön büyümesinin yüz morfolojisi üzerine etkileri

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ABSTRACT

Objective: The aim of this retrospective study was to investigate the effects of different vertical growth pattern on sagittal structures.

Methods: The material consisted of cephalometric films of untreated 50 Class II subjects, 24 boys and 26 girls, aged 9 to 12 years. Subjects were divided into three groups with increased vertical facial growth pattern (SN/GoGn>32^0), normal vertical facial growth pattern (280≤SN/GoGn≤32^0) and decreased vertical facial growth pattern (SN/GoGn<28^0). Differences between vertical groups were assessed by the means of variance analyses and least significant difference (LSD) test. And correlation coefficient between vertical groups and other variables were calculated.

Results: SNA ($P < .01$), SNB ($P < .05$), Gonial angle ($P < .001$), Jarabak ratio ($P < .001$) and IMPA ($P < .01$) were found to be related with vertical growth pattern. Negative correlation was found between SN/GoGn and SNA, SNB, IMPA angles and Jarabak ratio, and also positive correlation was observed between SN/GoGn and Gonial angle.

Conclusion: The change in vertical growth pattern influenced sagittal parameters of face.

Keywords: Growth and development, maxilla, mandible, vertical dimension, maxillofacial development

ÖZ

Amaç: Bu retrospektif çalışmanın amacı farklı vertikal yüz gelişim paterninin sagittal yapılar üzerine olan etkisini incelemektir.

Yöntemler: Çalışma materyalini, yaşları 9 ile 12 arasında değişen 24 erkek ve 26 kız olmak üzere tedavi edilmemiş 50 Sınıf II vakanın sefalmetrik filmleri oluşturmaktadır. Bireyler dikey yüz büyümesi artmış bireyler (SN/GoGn> 32^0), dikey yüz büyümesi normal olan bireyler (280≤SN/GoGn≤32^0) ve dikey yüz büyümesi azalmış bireyler (SN/GoGn<28^0) olmak üzere 3 gruba ayrılmıştır. Vertikal gruplar arasındaki farklılıklar varyans analizi ve LSD testi ile değerlendirilmiştir. Dik yön ile diğer değişkenler arasındaki korelasyon katsayısı belirlenmiştir.

Bulgular: SNA ($P < .01$), SNB ($P < .05$), Gonial açı ($P < .001$), Jarabak oranı ($P < .001$) ve IMPA ($P < .01$) farklı vertikal gelişim paternleriyle ilişkili bulunmuştur. SN/GoGn ile SNA, SNB, IMPA açıları ve Jarabak oranı arasında negatif, Gonial açı ile de pozitif korelasyon saptanmıştır.

Sonuç: Dikey yüz gelişimdeki değişiklikler yüzün sagittal gelişimi etkilemektedir.

Anahtar Kelimeler: Büyüme ve gelişim, maksilla, mandibula, vertikal boyut, maksilofasiyal gelişim

INTRODUCTION

The vertical growth of face has an important effect on the transversal and sagittal development of craniofacial structure.[1]

To create well balanced occlusion, static growth which related to the amount of direction of facial growth, and dynamic growth, which relates to the ratio and timing of facial growth, must be synchronize with each other. Regional imbalances may arise due to the fact that these two types of growth do not occur simultaneously during the growth and development process of the face. These regional imbalances are tried to be compensated in order to restore the balance in the whole craniofacial structure.[2]

Many studies have been conducted on growth and various theories have been proposed. [1, 3] One of the most widely accepted theories is the "functional matrix" theory proposed by Moss (1962). [4, 5] According to this theory, growth in the cranium is a combination of growth in cranial functional matrix and the response of skeletal tissues to this growth.

In the postnatal period, the growth and development of the face occurs in all three directions of space. However, the amount and speed of growth in each direction is different. The maximum growth is seen in vertical direction. [6-12]

In mouth breathing person, the mandible is located inferiorly. Also, in the oral cavity, the tongue settles on the base of the mandible. The location of tongue causes the perioral muscles to be hypotonic. This

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happens malocclusion to develop. Premature molar eruptions are observed in individuals who make mouth breathing to provide occlusal contact. Accordingly, the growth of the mandible is affected. Due to the rotation of the mandible to the posterior, an increase was observed in the vertical growth angles. [13]

It has been established that nasal airway capacity and respiratory type are affected vertical dentofacial morphology. [14] Mouth breathing due to nasal obstruction causes the posterior teeth to overdue and increases the height of the lower face. [15, 16] In the their study of monkeys, Yamada et al.[17] found that nasopharyngeal obstruction caused posterior rotation of the mandible, growth of the condyle up and back and increased gonial angle. Enlarged adenoid and tonsils, septum deviation large turbinates' and allergic problems are more common in hyperdivergent cases. Woodside et al.[18] reported a decrease in mandibular plane angle and anterior face height after removal of adenoid and tonsils.

The aim of this study was to examine the change of sagittal cranial structures in the subjects with different vertical growth pattern.

MATERIAL AND METHODS

For this retrospective study 50 subjects with Class II malocclusion were selected from patients referred to Orthodontic Department of RTE University. The mean ages of the female and male were 10.6 and 11.2 years, respectively (Table 1).

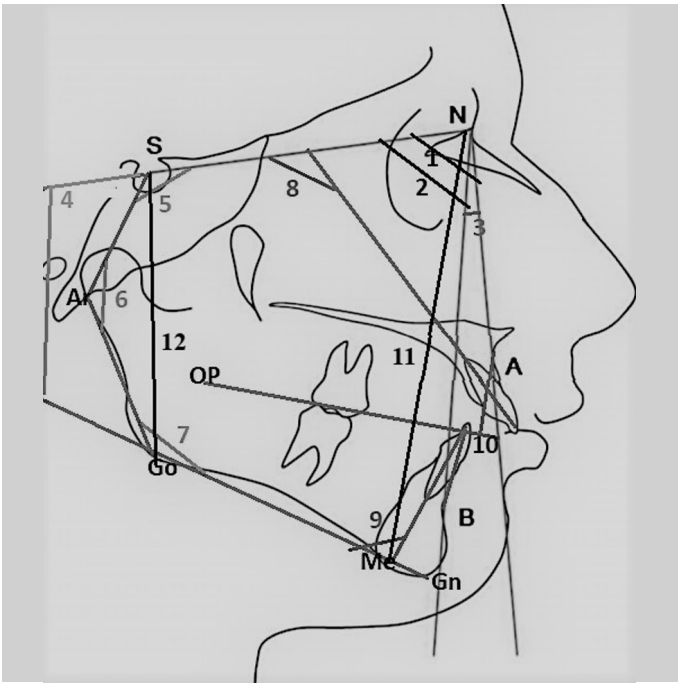

Figure 1. Cephalometric landmarks and measurements.

SNA; 2. SNB; 3. ANB; 4. SN/GoGn; 5. Saddle; 6. Articular; 7. Gonial; 8. I-SN; 9. IMPA; 10. Witts; 11. N-Me; 12. S-Go (SNA: Angle between Sella, Nasion and A Point; SNB: Angle between Sella, Nasion and B Point; ANB: Angle between A Point, Nasion and B Point; SN/GoGn: The angle between the SN and GoGn planes; Saddle Angle: The angle between Nasion, Sella and Articular; Articular Angle: The angle between Sella, Articular and Gonion; Gonial Angle: The angle between Articular, Gonial and Gnathion; I-SN: The angle between the long axis of the most forward upper incisor and SN plane; IMPA: The angle between the long axis of the most forward lower incisor and the mandibular plane; Witts: Perpendicular projection to occlusal line from the distance between A and B point; N-Me: It is the distance between Nasion and Menton points; S-Go: It is the distance between Sella and Gonial points)

For this retrospective study, the permission of the ethics committee was obtained from the Presidency of Non-Interventional Clinical Research Ethics Committee by the decision number 40465587-185 from RTE University. All participants were informed about the study.

The subjects were divided into three groups with regard to vertical facial growth by using SN/GoGn angle to define increased vertical facial growth (18) (> 32^0), normal vertical growth (15) (28^0 ≤SN/GoGn ≤32^0), decreased vertical facial growth (17) (<28^0) groups.

Selection criteria were; the subjects had Class II malocclusion (ANB>4^0C)[19], The patient had no craniofacial syndrome, the patient had no cleft lip and palate, conditions were complied with.

Standard lateral cephalometric radiographs (Planmeca ProMax 3D Classic) were taken from the individuals who made up the research groups. Lateral cephalometric radiographs were taken with the Frankfurt horizontal plane parallel to the ground under standard conditions while the teeth were in centric occlusion and the lips were at rest.

In the lateral cephalomeric films obtained from the patients under standard conditions, measurements were made with the analysis program (AudaxCeph ver 5.2.0.3610).

To determine the method errors associated with cephalometric tracing, 20 radiographs were selected randomly. The tracing was repeated 10 days after the initial measurements. The average difference between the first and second measurement was tested using a paired t-test, and a correlation analysis between the two readings was performed. The result of the paired t test result demonstrated no significant differences between the first and second mesurement.

Statistical analysis of the study was performed using Statistical Package for Social Science (SPSS Inc, Chicago, Illinois, USA) 18.0 for Windows software. Variance analysis was applied to determine which angles underwent statistically significant change in groups with different vertical development. When ANOVA were significant Least significant differences (LSD) test were used to compare the mean values of measurements between the groups. Correlation coefficient between Sn/GoGn and other variables were calculated.

In this retrospective study 9 angular, 1 linear, 1 rational measurements were used. SNA, SNB, ANB, SN/GoGn, Saddle, Articular, Gonial, I-SN, IMPA angles; Witts measurement and Jarabak ratio were used.

RESULTS

The ANOVA results, which determine the chronological age distribution of the subjects with increased, normal and decreased vertical facial growth pattern, are given in Table 1. And chronological age difference between the groups was not found biometrically significant.

The results of variance analysis are shown in Table 2. As can be seen from table the width of the distribution, mean and standard devia-

Table 1. Age and Sex distribution

	Group 1 High Angle	Group 2 Normal	Group 3 L ow Angle	F	*P*
Sex				0.6	0.76a
Male	9	7	8		
Female	9	8	9		
Age					
Mean	10.54	10.20	1.02	2.4	0.99a
SD	1.02	0.9	1.50		

a NS indicates not significant

Table 2. The F values from analysis of variance and result of post hoc test (LSD) showing the differences between the groups

	Group 1 High Angle	Group 2 Normal	Group 3 Low Angle			Post Hoc Test (LSD)		
Parameters	Ort ± SD	Ort ± SD	Ort ± SD	F values	*P*	1-2	1-3	2-3
SN/GoGn	39.72±4.05	32.13±1.10	24.67±1.11	147.09	.000***	.000***	.000***	.000***
SNA	78.94±2.78	82.70±2.79	82.20±2.92	8.945	.001**	.01**	.000***	.063
SNB	73.11±2.75	76.26±2.90	75.61±3.42	5.093	.010*	.05*	.05*	.58
Witts	2.80±1.86	4.10±3.42	4.94±2.33	3.064	.056	-	-	-
Saddle	125.22±4.41	125.06±4.63	124.94±8.08	.010	.990	-	-	-
Articular	148.61±6.31	144±7.81	145.11±9.16	1.599	.210	-	-	-
Gonial	125.66±4.91	123.53±5.08	117.41±5.33	12.110	.000***	.14	.000***	.001**
Jarabak	59.68±3.15	65.38±3.93	68.69±3.88	27.252	.000***	.000***	.000***	.05*
U1-SN	100.61±7.20	106.86±9.71	102.5±12.5	1.637	.200	-	-	-
IMPA	97.16±6.07	101±8.09	105.88±5.91	7.436	.002**	.06	.000***	.06

(*** $P < .001$, ** $P < .01$, * $P < .05$, SD: Standard deviation, LSD: Least significant difference)

Table 3. Pearson Correlation

PEARSON CORRELATION	SN/GoGn
SNA	-.501**
SNB	-.414
Gonial	.543**
Jarabak Rate	-.813**
IMPA	-.449

(**: $P < .01$)

tion values and the importance levels of the differences between the groups are presented. SNA ($P < .01$), SNB ($P < .05$), Gonial ($P < .001$), Jarabak ($P < .001$), IMPA ($P < .01$) angles were related to SN/GoGn angle.

LSD test results of the measurements associated with SN/GoGn are presented in Table 2. According to these results, Jarabak was found to vary across all groups (1-2; 1-3 $P < .001$, 2-3 $P < .05$). SNA and SNB were found to be different between high angle and normal groups and between high angle and low angle groups (SNA 1-2, $P < .01$, 1-2 $P < .001$; SNB $P < .05$). Gonial was found to be different between high angle and low angle groups and between normal and low angle groups (1-3 $P < .001$, 2-3 $P < .01$). There was a significant difference in the IMPA between high angle and low angle groups ($P < .001$).

The values of correlation analysis are given in Table 3. The negative correlation was found between SN/GoGn and SNA (r:-.501), Jarabak ratio (r:-.813) and positive correlation was determined with Gonial angle (r:.543) and SN/GoGn.

DISCUSSION

The growth of the craniofacial structures is a complex biological process that occurs through reciprocal interactions between genetic and environmental factors. Several theories have been put forward as to how craniofacial growth occurs and to what extent genetic and environmental factors influence growth [5, 20, 21].

Sicher, [21] suggested that craniofacial growth is mainly controlled by internal genetic factors that direct craniofacial bone cells, claiming that some of the changes in bone occur due to local environmental factors .

In the literature, studies examining the vertical compensation mechanism have been performed by ignoring sagittal direction anomalies in individuals with increased vertical direction dimensions [22-25]. Various studies evaluating the relationship between craniofacial structures in sagittal and vertical directions have reported that sagittal and vertical direction growths of the face are related. Therefore, independent evaluation of the features of these two growth directions may be misleading [26].

Facial growth is forward and downward in a balanced way in the sagittal and vertical directions. During the realization of the growth pattern, the balance between the constituent structures may be disrupted and the face may grow more or less in the vertical direction. Vertical changes may be observed due to environmental effects. In individuals with increased mouth breathing, vertical direction development increases.[8, 27, 28]

In an analysis of the effects of mouth breathing on horizontal and vertical face development, Ceylan et al. [29] found a relationship between the development of craniofacial structures and the form of breathing.

In our study we examined the effect of different vertical growth pattern on the sagittal growth of craniofacial structures, and we observed that as vertical direction development increases; sagittal direction decreases.

And we have observed that statistically significant differences were found in SNA, SNB, Gonial angle, Jarabak ratio and IMPA while the vertical growth increased. There are some studies supporting these results.[30-37] Chung and Wong [30] reported that SNA and SNB angles decreased in the cases with increased vertical growth pattern. In the study of Japanese girls with Class II skeletal relationships, Ishii et al. [34] reported that SNA and SNB angle decreased as the height of the face increased. And correlation analysis was used to determine the associations between vertical growth pattern and other significant variables and negative correlation was found between Jarabak rate and IMPA. And it was observed that antero-posterior (SNA, SNB) values decreased while vertical angles increased.

And also we observed that the Gonial angle was related with vertical growth. The correlation analysis showed, a positive relationship between the vertical direction and the gonial angle. These findings are consistent with the findings of other studies.[30-37] They also stated that the gonial angle differs according to the mandibular rotation model.[30-37] Thompson and Popovich [33] reported that as vertical growth increases, the gonial angle increases.

In our research, negative correlation was detected between SN/GoGn and IMPA which is the angle indicating the inclination of the lower incisors according to their own base, and face development. In other words, IMPA decreased while vertical growth increases. This finding is in agreement with Rübendüz and Esenlik.[38]

CONCLUSION

The findings from this study can be summarized as follows:

1. SNA, SNB, Gonial angle, IMPA and Jarabak ratio found to be associated with vertical growth pattern.
2. Positive correlation was found SN/GoGn and Gonial angle, whereas negative correlation was detected SN/GoGn and SNA, Jarabak ratio, IMPA.
3. As a result of these findings, increased vertical facial growth angles cause a decrease in sagittal facial development angles.

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