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Craniofacial morphology in patients with Angle Class II division 2 malocclusion

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Abstract

Cephalometric analysis is frequently used in orthodontics for diagnostic purposes, in order to evaluate the positional relationship of the upper and lower jaw to the cranial base, as well as to objectively asses the way dental arches relate to one another and to the skeletal base. As with other dento-skeletal anomalies, the normal growth process can induce changes in these parameters. The purpose of this study is to evaluate the skeletal and dental changes that occur in growing patients with Angle Class II division 2 malocclusion. The study also focuses on analyzing and comparing several parameters in three groups of young patients of different ages, diagnosed with Class II division 2 malocclusion, in order to determine whether the anomaly worsens or improves during the patients' growth period. A total of 25 lateral skull teleradiographs were analyzed using cephX. The patients were divided into three groups (Group 1: 6–8 years, Group 2: 9–14 years, Group 3: 15–18 years). We used the cephalometric parameters described in Björk–Jarabak and Tweed analyses, as well as the relationship of the upper and lower central incisors to the skeletal landmarks. The statistical methods used in this study were the analysis of variance (ANOVA) and the unpaired Student's *t*-test ($p<0.05$). We concluded that, during the physiological growth process, the Angle Class II division 2 malocclusion has the following cephalometric characteristics: the maxillary central incisors were in accentuated retroclination, the interincisal angle was very obtuse, the gonial angle showed lower than normal values towards the end of the growth period, the lower anterior face height was definitely decreased, the mandibular body length was shorter than normal in the early growth period and the tendency towards a hypodivergent skeletal pattern remained stable during growth.

Keywords: Class II division 2, malocclusion, cephalometric analysis, craniofacial morphology.

Introduction

Malocclusion is the direct result of the interaction between the position of the jaws and the position of the teeth; therefore, the position of the teeth is affected by intermaxillary relationships. Skeletal discrepancies show better results when treated during the growth period. When analyzed cephalometrically, apparently similar malocclusions will clearly show significant differences between dento-facial proportions [1–4]. Cephalometric analysis is a very useful diagnostic method used to assist the clinicians in determining facial disharmonies in order to systematize therapeutic measures during treatment and to influence facial growth [1].

Technological development leads to a higher frequency usage of specialized computer software in cephalometric analysis. This is generically named computer-aided digital cephalometry.

Angle's comprehensive definition of Class II division 2 (Class II/2) malocclusion appeared in the 7th edition of the "*Treatment of malocclusion of the teeth and fractures of the maxillae*" [5]. The definition was based on clinical dento-alveolar patterns, because of the lack of radiographic investigations at that time [1].

Over the years, the original definition had been constantly modified [2–4]. The definition of Class II/2 malocclusion was eventually simplified by characterizing it as a malocclusion in which the molars and the canines are in distocclusion and the maxillary central incisors are retroclined [1, 6–9].

Class II/2 malocclusion can be associated with various types of craniofacial morphologies [2, 4, 10]. The skeletal pattern in Class II/2 malocclusions usually shows an orthognathic maxilla, relatively short and retrognathic mandible, a hypodivergent facial pattern, relatively prominent chin, retroclined maxillary central incisors and a deep overbite [1].

The purpose of this study is to evaluate the skeletal and dental changes that occur in growing patients with Angle Class II division 2 malocclusion using Björk–Jarabak and Tweed analyses. The study also focuses on analyzing and comparing several parameters in three groups of young patients of different ages, diagnosed with Class II division 2 malocclusion, in order to determine whether the anomaly worsens or improves during the patients' growth period.

Patients and Methods

The present study was conducted on 25 patients diagnosed with Angle Class II division 2 malocclusion,

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in the Department of Pedodontics and Orthodontics, at the Faculty of Dental Medicine, "Victor Babeş" University of Medicine and Pharmacy, Timişoara, Romania, over a period of five months (February–July 2012).

The patients were selected using the following criteria: Angle Class II molar and canine relationship; deep occlusion; at least two retroclinated incisors; complete dental arches, except the third molar; no significant past medical history; no dental trauma; no background of orthodontic, surgical or prosthodontic treatment.

The selected patients were divided into three groups, according to their age: Group 1 (seven patients, 6–8-year-old, four females and three males), Group 2 (nine patients, 9–14-year-old, four females and five males), and Group 3 (nine patients, 15–18-year-old, five females and four males).

Lateral skull teleradiographs (lateral cephalograms) were obtained from all of the patients. The digital copies of the lateral cephalograms were analyzed using a cephalometric analysis web based service (cephX). Experienced cephX professionals in Las Vegas, NV, USA, carried out the cephalometric tracings. The results of the cephalometric analyses and the growth predictions were readily accessible within two working days.

We analyzed the following parameters: the facial heights, the relationship between upper and lower central incisors, their position, the interincisal angle, the dento-skeletal relationship between the upper and lower jaw and the gonial angle. We used the cephalometric parameters described in Björk–Jarabak and Tweed's analyses, as well as the relationship of the upper and lower incisors to the skeletal landmarks.

The statistical analyses and the interpretation of the results were carried out in the Department of Biostatistics and Medical Informatics, "Victor Babeş" University of Medicine and Pharmacy, Timişoara. The use of specialized software was employed to analyze the data (SPSS 17, OpenEpi 2.3.1).

The statistical analyses consisted in: counting frequencies and calculating percentages for qualitative variables; calculating arithmetic means, standard deviations, minimum and the maximum values for quantitative variables; comparing two independent sample means (unpaired *t*-test); comparing three independent sample means (ANOVA).

The analysis of variance (ANOVA) was used to test for differences among the three groups, while the unpaired Student's *t*-test was used to determine whether there were any significant differences between the means of Group 1 and Group 3.

The level of statistical significance was assessed as follows: $p>0.05$ – no statistically significant differences; $p<0.05$ – statistically significant differences; $p<0.01$ – highly statistically significant differences; $p<0.001$ – very highly statistically significant differences; $p<0.0001$ – extremely statistically significant differences.

Results

The results of the Björk–Jarabak analysis and the statistical evaluation of the data are presented in Table 1.

Table 1 – *The results of the Björk–Jarabak analysis and the statistical evaluation of the data*

Parameter	Descriptor	Measurement units	Normal mean value	SD	Mean			*p* ANOVA	*p* Student's *t*-test
					Group 1 (6–8 years)	*Group 2 (9–14 years)*	*Group 3 (15–18 years)*		
Saddle angle	N-S-Ar	deg	123.0	4.0	121.67	126.86	128.2	<0.0001****	<0.0001****
Articular angle	S-Ar-Go	deg	143.0	5.0	143.11	141.65	138.83	0.0620	0.0240*
Gonial angle	Ar-Go-Gn	deg	130.0	5.0	128.10	124.09	121.52	0.0026**	0.0234*
Sum of angles		deg	396.0	20.0	392.88	392.60	388.55	0.7924	0.5516
Upper gonial angle	Ar-Go-N	deg	53.0	2.0	60.21	57.92	54.58	<0.0001****	<0.0001****
Lower gonial angle	N-Go-Gn	deg	73.0	3.0	73.91	67.60	66.92	<0.0001****	<0.0001****
Upper central incisor to SN angle	UI-SN	deg	103.0	4.0	87.49	85.44	82.75	0.0073**	0.0025**
Lower central incisor to SN angle	LI-SN	deg	100.0	5.0	95.77	89.11	88.40	<0.0001****	0.0003***
Anterior cranial base length	S-N	mm	71.0	10.0	62.06	73.92	74.03	0.0017**	0.0023**
Posterior cranial base length	S-Ar	mm	32.0	5.0	27.95	34.01	36.88	<0.0001****	<0.0001****
Mandibular ramus height	Ar-Go	mm	44.0	5.0	36.66	42.22	45.33	<0.0001****	<0.0001****
Mandibular body length	Go-Gn	mm	71.0	8.0	60.31	71.81	74.66	<0.0001****	<0.0001****
Posterior face height	S-Go	mm	–	–	61.19	64.80	77.65	–	–
Anterior face height	N-Gn	mm	–	–	93.21	105.72	114.20	–	–
Upper anterior face height	N-ANS	%	45.0	3.0	49.00	48.00	48.00	0.5679	0.3613
Lower anterior face height	ANS-Gn	%	55.0	3.0	51.00	51.00	51.00	0.5679	0.3613

SD – Standard deviation; *Statistically significant differences ($p<0.05$); **Highly statistically significant differences ($p<0.01$); ***Very highly statistically significant differences ($p<0.001$); ****Extremely statistically significant differences ($p<0.0001$).

Angular measurements for the Björk–Jarabak analysis

The saddle angle (N-S-Ar) increased with age and showed extremely statistically significant differences between the groups ($p<0.0001$).

The articular angle (S-Ar-Go) was not statistically different in the three groups, but the *t*-test showed a statistically significant difference between Group 1 and Group 3 ($p<0.05$). A lower limit value was observed for Group 3.

The gonial angle (Ar-Go-Gn) decreased with age and revealed highly statistically significant differences between the groups ($p<0.01$). The *t*-test showed a statistically significant difference between Group 1 and Group 3 ($p<0.05$).

The sum of the saddle, articular and gonial angles was within the normal value range.

Both the upper gonial angle (Ar-Go-N) and the lower gonial angle (N-Go-Gn) decreased with age and showed extremely statistically significant differences between the three groups ($p<0.0001$).

The angle between the upper central incisors and the anterior cranial base (UI-SN) decreased during the patients' growth period and was highly statistically different in the three groups ($p<0.01$).

The angle between the lower central incisors and the anterior cranial base (LI-SN) also decreased with age and was extremely statistically different in the three groups ($p<0.0001$). The *t*-test showed a very highly statistically significant difference between Group 1 and Group 3 ($p<0.001$).

Linear measurements for the Björk–Jarabak analysis

The anterior cranial base length (S-N) and the posterior cranial base length (S-Ar) were found to have normal values. The S-N values were highly statistically different ($p<0.01$), while the S-Ar values were extremely statistically different ($p<0.0001$) in the three groups.

The mandibular ramus height (Ar-Go) and the mandibular body length (Go-Gn) increased with age and were extremely statistically different in the three groups ($p<0.0001$).

The posterior face height (S-Go) and the anterior face height (N-Gn) increased with age in all the groups.

The upper anterior face height (N-ANS) and the lower anterior face height (ANS-Gn) were not statistically different in the three groups. Upper limit values were observed for N-ANS in Group 2 and 3, while ANS-Gn values were lower than normal in all the groups. The measurements were recorded as percentage values of the total anterior face height.

Tweed's analysis

The results of the Tweed analysis and their statistical evaluation are presented in Table 2.

Table 2 – ***The results of the Tweed analysis and the statistical evaluation of the data***

Parameter	Measurement units	Normal mean value	SD	Mean			*p* Student's *t*-test
				Group 1 (6–8 years)	*Group 2 (9–14 years)*	*Group 3 (15–18 years)*	
FMA	deg	28.0	3.0	27.89	23.51	23.04	<0.0001****
FMIA	deg	62.0	3.0	67.70	67.06	69.25	0.1613
IMPA	deg	90.0	5.0	84.41	89.43	87.71	0.0766

SD – Standard deviation; ****Extremely statistically significant differences ($p<0.0001$).

The FMA angle decreased with age and showed extremely statistically significant differences between Group 1 and Group 3 ($p<0.0001$). Lower than normal values were observed for Group 2 and 3 because of the decrease in the lower anterior face height. The decreased FMA angle led to an increased FMIA angle, above the normal values. The IMPA angle was within the normal value range.

The relationship of the upper and lower central incisors to the skeletal landmarks

The relationship of the upper and lower central incisors to the skeletal landmarks and the statistical evaluation of the data are presented in Tables 3 and 4.

The interincisal angle (LI-UI) revealed higher than normal values in all the groups, because of the retrusion of the upper central incisors.

Table 3 – ***The statistical evaluation of the relationship between the lower central incisors and the skeletal landmarks***

Parameter	Descriptor	Measurement units	Normal mean value	SD	Mean		
					Group 1 (6–8 years)	*Group 2 (9–14 years)*	*Group 3 (15–18 years)*
Lower central incisor to NB angle	*LI-NB*	deg	22.0	4.0	14.37	17.98	20.49
Lower central incisor to NB distance	*LI-NB*	mm	4.0	2.0	0.83	2.11	2.78
Lower central incisor to AP line distance	*LI-AP*	mm	0.0	2.0	-1.28	-1.58	-4.50
Lower central incisor to mandibular plane angle	*LI-GoGn*	deg	90.0	5.0	78.27	82.42	86.05
Interincisal angle	*LI-UI*	deg	131.0	13.0	152.92	155.31	157.64

SD – Standard deviation.

Table 4 – ***The statistical evaluation of the relationship between the upper central incisors and the skeletal landmarks***

Parameter	Descriptor	Measurement units	Normal mean value	SD	Mean		
					Group 1 (6–8 years)	*Group 2 (9–14 years)*	*Group 3 (15–18 years)*
Upper central incisor to NA angle	UI-NA	deg	24.0	4.0	7.89	12.00	8.69
Upper central incisor to NA distance	UI-NA	mm	4.0	2.0	-1.32	-1.55	-2.59
Upper central incisor to AP line distance	UI-AP	mm	6.0	3.0	3.24	3.25	3.54
Upper central incisor to SN angle	UI-SN	deg	103.0	4.0	87.49	85.44	82.75

Parameter	Descriptor	Measurement units	Normal mean value	SD	Mean		
					Group 1 (6–8 years)	*Group 2 (9–14 years)*	*Group 3 (15–18 years)*
Upper central incisor to Frankfurt plane angle	UI-FR	deg	100.0	5.0	95.77	102.59	104.44
Upper central incisor to palatal plane angle	UI-PAL	deg	110.0	5.0	97.38	101.76	105.50

SD – Standard deviation.

The angle between the lower central incisors and the NB line (LI-NB) was found to have lower than normal values in Group 1 and 2.

The linear measurements of the relationship between the upper central incisors and the NA line (UI-NA mm) showed negative values, because the central upper incisors were retruded, in their attempt to compensate for the difference between the upper and lower jaws.

The dento-alveolar relationships of the upper and lower central incisors are schematically represented in Figures 1 and 2.

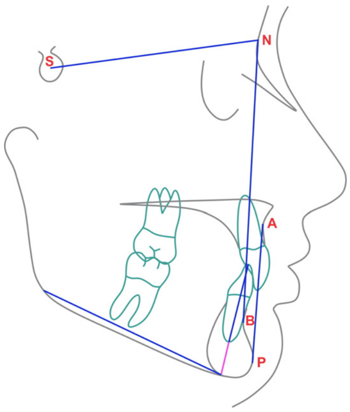

Figure 1 – *The schematic relationship of the lower central incisors to the skeletal landmarks.*

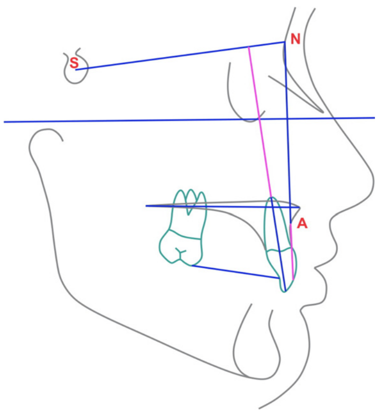

Figure 2 – *The schematic relationship of the upper central incisors to the skeletal landmarks.*

Discussion

The classification and the characteristics of Class II/2 malocclusion compared to other malocclusions are still a source of disagreement among orthodontists. Several factors might contribute to this controversy: the composition of each study group (mean age, age range, selection criteria, sample size, ethnic background etc.), the variations in the definition and identification of cephalometric landmarks and the statistical methods used [2, 11]. The results in this study, which contradict the results of previous studies in the literature, might also be attributed to the use of different reference lines and to the fact that this study evaluated patients' characteristics during different growing stages.

In order to establish a thorough cephalometric characterization of the study groups, we included in our evaluation a significant number of widely used skeletal and dental cephalometric parameters from Björk–Jarabak and Tweed's analyses. The results of this study demonstrate that our findings are in agreement with previously published studies [11–14].

In the literature, in patients with Class II/2 malocclusion, the mandible is described as being small [13–18] and retrognathic [11–14, 17], when compared with Class I malocclusion cases. The mandible is also described as being longer and more prognathic in patients with Class II/2 malocclusion, in comparison to Class II/1 malocclusion cases [11–14, 16].

The results of the present study revealed an extremely significant increase in both the ramus height and body of the mandible in all three groups.

In the vertical plane, Class II/2 malocclusion is characterized by a flat mandible plane, an acute gonial angle, an increased posterior facial height, a decreased anterior facial height and a predominantly horizontal growth vector [2, 11]. We found a decreased lower facial height in all of the patients and the tendency towards a hypodivergent skeletal pattern remained stable in all the groups. A review of the literature shows a broad agreement regarding the increased posterior facial height in Class II/2 malocclusion [11, 18].

Regarding the values of the FMA angle from Tweed's analysis, we found this angle to have decreased values, showing the characteristic hypodivergent skeletal pattern in patients with Class II/2 malocclusion.

Our findings are in agreement with previous studies in the literature regarding the dentoalveolar cephalometric characteristics of the patients with Class II/2 malocclusion, such as an accentuated retroclination of the maxillary central incisors, an obtuse interincisal angle and a deep overbite [11, 16–20].

When referring to the lower incisors, numerous studies have described them as being retroclined [11], whereas other studies [18–20] found these incisors to have a normal position. In this study, we found the retroclination of the lower incisors relative to both the SN and mandibular plane, in all the groups. However, the decrease of IMPA angle was not significant.

The results of the present study demonstrated a retro-inclined position of the upper central incisors relative to the SN and NA lines.

The interincisal angle was significantly increased in all the groups. During the physiological growth process the tendency for retroclined upper incisors and increased interincisal angle is maintained.

Conclusions

During the physiological growth process, we found that the Angle Class II/2 malocclusion had distinctive cephalometric characteristics. Lower than normal values were found in the lower anterior face height (in all the groups), the gonial angle (towards the end of the growth period) and the mandibular body length (in the early growth period). The mandibular growth vector was predominantly horizontal and the tendency towards a hypodivergent skeletal pattern remained stable during growth. The maxillary central incisors were retroclined and the interincisal angle was found to be very obtuse. All our findings suggest that the Angle Class II/2 malocclusion should be considered an independent dento-skeletal anomaly, which differs in almost all of its characteristics from both Class I and Class II/1 malocclusions.

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