Relationship between the vertical craniofacial disproportions and the cervicovertebral morphology in adult subjects

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SUMMARY
Introduction Orthodontic diagnosis includes the interpretation of the relations between the craniofacial and cervical system, given the potential impact of the irregularities from one system to another.
Objective The aim of this study was to examine morphological characteristics of the cervical spine, depending on the parameters of the vertical craniofacial growth and gender in adult subjects.
Methods The sample comprised lateral cephalograms of 120 subjects with different vertical facial growth, aged 17.5–35 years. Measured parameters were the following: anterior and posterior vertebral body height (ABHC2–C5, PBHC2–C5), anterior and posterior intervertebral space (AISC2–C5, PISC2–C5), distance between vertebrae and point sella (SC2, SC3, SC4), pterygomaxillare (PmC2), gonion (GoC2) and basion (BaC4); cervical spine angulation (OPT/CVT) and inclination (OPT/HOR, CVT/HOR).
Results Results showed that subjects with anterior facial growth rotation have greater values for BaC4, OPT/HOR, CVT/HOR, OPT/CVT, anterior and posterior vertebral body heights and intervertebral spaces, and lower values for GoC2 and PmC2. Higher values in males were found for anterior and posterior vertebral body heights, distances SC2, SC3, SC4, and BaC4. In females, the greater values were found for GoC2 and OPT/CVT.
Conclusion Subjects with anterior facial growth rotation have greater cervical spine inclination and angulation, higher cervical vertebrae and intervertebral spaces, longer upper cervical spines and shorter distances GoC2 and PmC2. Males show smaller cervical column curvature, but higher cervical vertebrae and greater length of the upper cervical spine.
Keywords: craniofacial morphology; facial growth rotation; cervical vertebrae

INTRODUCTION

The morphology of the cervical spine and the craniofacial system is related to a variety of factors, such as gender [1-4], age [5], ethnic origin [3, 6], the diseases and dysfunctions of the airway and temporomandibular joint [7, 8]. The previous studies show that a mutual relation exists between the two systems as well, and that they are closely related since the earliest, prenatal period. The notochord determines the development of the cervical vertebrae, especially the vertebral bodies and the posterior part of the cranial base; the vertebral arches and remaining parts of the occipital bone are formed from the para-axial mesoderm; while the jaws, including the condylar cartilage, develop from the tissue that derives from the neural crest [1]. It is believed that the signaling during early embryogenesis between the notochord, the para-axial mesoderm, the neural tube and the neural crest explains the relationship between the cervical spine and the craniofacial structures [1].

Mutual influence of the cervical spine and craniofacial system continues after birth, during growth and development. The facial growth pattern (anterior or posterior rotation) can lead to vertical craniofacial disproportions, i. e. deep or open bite, but it also affects the sagittal relationship between the jaws and can cause potential disproportions in that plane. Previous studies have confirmed the impact of both the vertical [9-13] and the sagittal parameters of the craniofacial system [4, 10-18] on the cervicovertebral morphology.

OBJECTIVE

Given the potential influence of the irregularities from one system to another, the modern principles of orthodontic diagnosis include the interpretation of the relations between the craniofacial and cervical system. However, there are few studies that have investigated the relationship between the vertical craniofacial traits and the morphology and position of the cervical vertebrae, and further investigation in this field is required.

Therefore, the aims of this study were to examine and compare the cervicovertebral morphology in subjects with different vertical facial growth patterns, as well as to determine the differences in the cervicovertebral morphology between genders.

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METHODS

The sample comprised lateral cephalometric radiograms of 120 patients selected by the random sampling method, admitted for treatment to the Clinic of Orthodontics, Faculty of Dental Medicine, University of Belgrade. The inclusion criteria were as follows: the age of subjects between 17.5 and 35 years; quality of the lateral cephalometric radiograms – the visibility of C2–C5 vertebrae; absence of any craniofacial or cervicovertebral anomalies or syndromes and temporomandibular joint disorders; no history of orthodontic or surgical treatment prior to the recording of the films.

The lateral cephalometric radiographs were taken by using a standardized technique on a Planmeca cephalometer (ProMax, Helsinki, Finland). The cephalograms were taken in the natural head position of the subjects. This procedure ensured standardized positioning not only of the head but also of the cervical column [12]. All radiographs were traced manually, using acetate paper placed on top of the film on the negatoscope, and the linear and angular measurements were taken by a single observer. All linear measurements were converted into real values.

Considering the fact that there are numerous factors which influence vertical facial growth, the distribution of the sample in this research was done based on the three parameters that describe the vertical facial morphology most appropriately. Vertical craniofacial traits were assessed by using the following three parameters: mandibular plane angle – SN/MP (parameter I), Jarabak's analysis (parameter II), and the sum of Bjork's polygon angles (parameter III). The subjects were divided into two groups according to the facial growth pattern. Group 1 included the patients with anterior facial growth rotation (SN/MP ≤32°, Jarabak's analysis ≥65% and Bjork's polygon ≤393°), while Group 2 included the subjects with posterior facial growth rotation (SN/MP ≥33°, Jarabak's analysis ≤62% and Bjork's polygon ≥399°). On each radiogram craniofacial variables (Table 1, Figure 1) and cervical variables (Table 2, Figures 2, 3, and 4) were measured and used to assess cervicovertebral morphology in subjects with different vertical facial growth patterns.

Table 1. Craniofacial measurements used in this study

Variable	Definition	Groups
1. SN/MP (°)	Mandibular plane angle – the angle of the mandibular plane in relation to the cranial base	Group 1: ≤32° – anterior rotation of the mandible Group 2: ≥33° – posterior rotation of the mandible
2. Jarabak's analysis (%)	Relation of posterior (SGo) to anterior facial height (NMe)	Group 1: ≥65% – anterior facial growth rotation Group 2: ≤62% – posterior facial growth rotation
3. The sum of Bjork's polygon angles (°)	Sum of the angles NSAr, SArGo and ArGoGn	Group 1: ≤393° – anterior facial growth rotation Group 2: ≥399° – posterior facial growth rotation

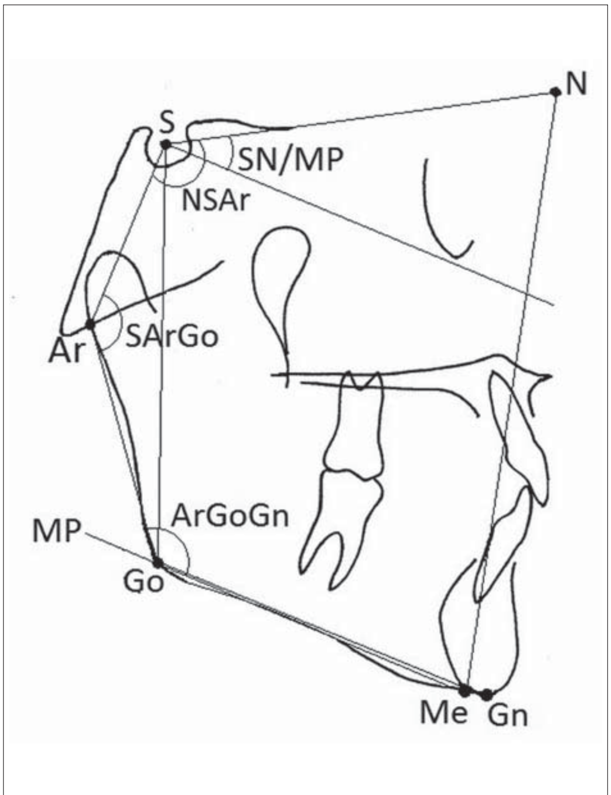

Figure 1. Craniofacial variables

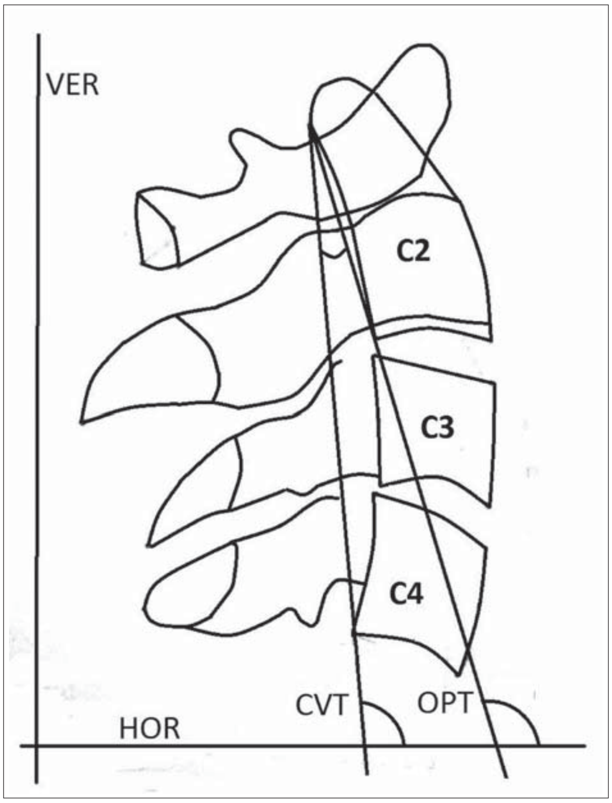

Figure 2. Angular cervical variables

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Table 2. Cervicovertebral measurements used in this study

Variable			Definition
Angular cervical variables (°)	4. OPT/HOR	Cervical column inclination	The angle between OPT – odontoid process tangent (the tangent line to the odontoid process that passes the postero-superior and the postero-inferior points of the body of C2) – and HOR (true horizontal)
	5. CVT/HOR	Cervical column inclination	The angle between CVT – cervical vertebra tangent (the tangent line to the odontoid process that passes the postero-superior point of the body of C2 and postero-inferior point of the body of C4) – and HOR
	6. OPT/CVT	Cervical column angulation (cervical curvature, lordosis)	The difference between angles OPT/HOR and CVT/HOR
Linear cervical variables (mm)	7. ABHC2–C5	Anterior heights of the bodies of C2–C5	The distance between the antero-superior and antero-inferior points of the bodies of C2–C5
	8. PBHC2–C5	Posterior heights of the bodies of C2–C5	The distance between the postero-superior and postero-inferior points of the bodies of C2–C5
	9. AISC2–C5	Anterior intervertebral space of the cervical vertebrae	The anterior distance between the bodies of C2–C5
	10. PISC2–C5	Posterior intervertebral space of the cervical vertebrae	The posterior distance between the bodies of C2–C5
	11. BaC4	Total vertical dimension of the upper cervical spine	The distance between the point basion and the antero-inferior point of the body of C4, measured along the line perpendicular to the Frankfort horizontal plane
	12. SC2	Vertical position of C2 relative to the cranial base	The distance between the point sella and the antero-inferior point of the body of C2, measured along the line perpendicular to the Frankfort horizontal plane
	13. SC3	Vertical position of C3 relative to the cranial base	The distance between the point sella and the antero-inferior point of the body of C3, measured along the line perpendicular to the Frankfort horizontal plane
	14. SC4	Vertical position of C4 relative to the cranial base	The distance between the point sella and the antero-inferior point of the body of C4, measured along the line perpendicular to the Frankfort horizontal plane
	15. PmC2	Vertical position of C2 relative to the maxilla	Vertical distance between the point pterygomaxillare and the antero-inferior point of the body of C2, measured along the line perpendicular to the Frankfort horizontal plane
	16. GoC2	Vertical position of C2 relative to the mandible	Vertical distance between the point gonion and the antero-inferior point of the body of C2, measured along the line perpendicular to the Frankfort horizontal plane

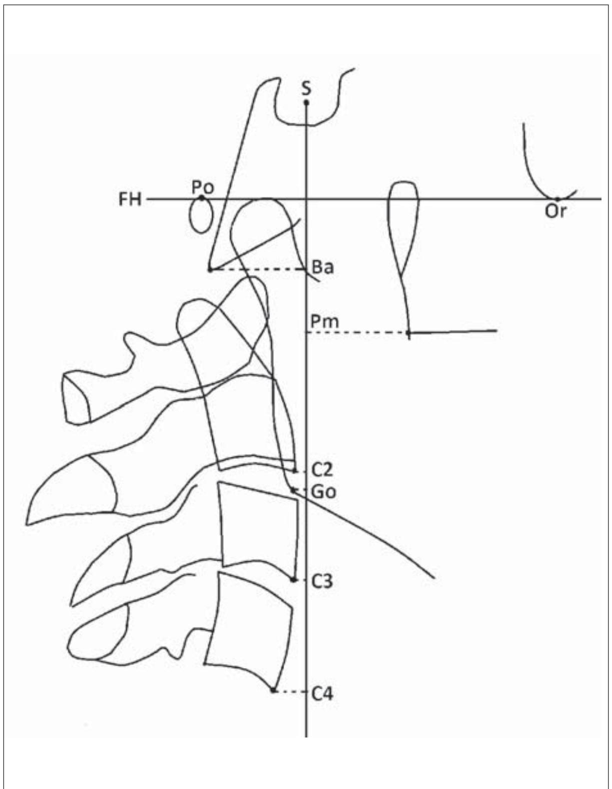

Figure 3. Vertical cervical variables measured along the line perpendicular to the Frankfort horizontal plane (FH)

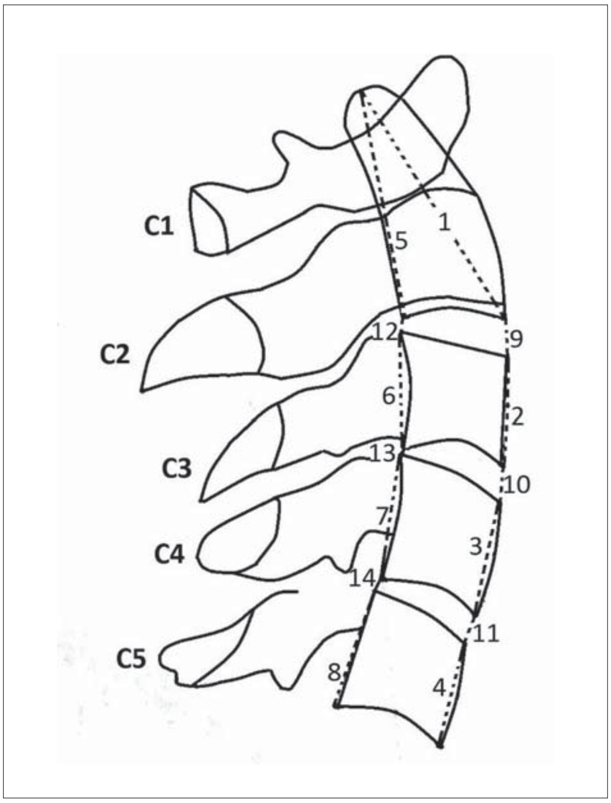

Figure 4. The heights of the bodies of the cervical vertebrae and the intervertebral spaces
(1)-(4) ABHC2–C5; (5)-(8) PBHC2–C5; (9)-(11) AISC2–C5; (12)-(14) PISC2–C5

Statistical analysis

All statistical analyses were performed in IBM SPSS Statistics for Window Software Version 20.0 (IBM Corp., Armonk, NY, USA). Results were presented as mean and standard deviation. Stydents t-test and Mann–Whitney U-test were used to compare the two groups of subjects. All p-values less than 0.05 were considered statistically significant.

RESULTS

This study included 120 subjects, 60 males and 60 females. The age of the participants ranged between 17.5 and 35 years, with the mean age (±SD) 22.3±4.4 years. Table 3 shows the distribution of subjects among different vertical facial growth patterns determined by the three vertical craniofacial parameters.

The differences in the inclination and the angulation of the cervical spine between the subjects with different facial growth pattern are shown in Table 4. The inclination (OPT/HOR, CVT/HOR) and the angulation of the cervical spine (OPT/CVT) showed higher values in Group 1. The angles OPT/HOR and CVT/HOR showed statistically significant differences between groups regarding parameters I (p<0.01) and III (p<0.01 and p<0.05).

The heights of the bodies of the cervical vertebrae and intervertebral spaces in subjects with different facial growth pattern are shown in Table 5. The anterior body height of C2 and the anterior and posterior body heights of C3, C4 and C5 showed higher values in Group 1, while the posterior height of the body of C2 showed lower values, with no statistical significance. The anterior intervertebral spaces C2–C3, C3–C4, and C4–C5 showed higher values in Group 1. This difference showed statistical significance between groups regarding parameter I (p<0.05 for AISC2C3, p<0.01 for AISC3C4, p<0.05 for AISC4C5), II (p<0.05 for AISC2C3 and p<0.01 for AISC3C4), and III (p<0.05 for AISC2C3, p<0.01 for AISC3C4, p<0.05 for AISC4C5). The posterior intervertebral spaces C2–C3 and C4–C5 also showed higher values in Group 1, with no statistical significance.

The difference in vertical cervical values measured along the line perpendicular to the FH between the groups is shown in Table 6. Total vertical dimension of the upper cervical spine (BaC4) showed higher values in Group 1, with no statistical significance between the two groups. The vertical distance between the point gonion and the body of C2 (GoC2) showed higher values in Group 2, with statistical significant differences between the groups regarding all three parameters (p<0.001). The vertical distance between the point pterygomaxillare and the body of

Table 3. The distribution of subjects among different vertical facial growth patterns determined by three vertical craniofacial parameters

Vertical craniofacial parameters		Subjects	
		Male	Female
SN/MP	≤32°	23	18
	≥33°	37	42
Jarabak's analysis	≥65%	27	28
	≤62%	16	17
The sum of Bjork's polygon angles	≤393°	24	24
	≥399°	23	20

Table 4. The impact of the vertical craniofacial parameters on the inclination and the angulation of the cervical spine

Variable	Parameter I			Parameter II			Parameter III		
	Group 1 (n=41)	Group 2 (n=79)	p-value	Group 1 (n=54)	Group 2 (n=33)	p-value	Group 1 (n=43)	Group 2 (n=41)	p-value
OPT/HOR	92.84±8.49	87.72±8.57	**	91.32±9.03	86.65±8.71	NS	92.27±8.39	86.11±9.28	**
CVT/HOR	88.43±7.90	84.03±8.30	**	86.94±8.39	83.27±8.20	NS	87.71±7.73	82.82±9.05	*
OPT/CVT	4.61±3.31	3.65±3.25	NS	4.53±3.24	3.32±2.39	NS	4.79±3.13	3.20±2.57	NS

* p<0.05; ** p<0.01; *** p<0.001; NS – nonsignificant

Table 5. The impact of the vertical craniofacial parameters on the morphology of the cervical vertebrae

Variable	Parameter I			Parameter II			Parameter III		
	Group 1 (n=41)	Group 2 (n=79)	p-value	Group 1 (n=54)	Group 2 (n=33)	p-value	Group 1 (n=43)	Group 2 (n=41)	p-value
ABHC2	38.48±2.84	38.25±3.32	NS	38.54±2.86	38.22±3.76	NS	38.26±2.92	37.93±3.35	NS
ABHC3	13.81±1.59	13.54±1.58	NS	13.54±1.41	13.53±1.39	NS	13.80±1.57	13.30±1.51	NS
ABHC4	13.15±1.59	12.88±1.44	NS	12.95±1.64	12.90±1.31	NS	13.14±1.60	12.79±1.32	NS
ABHC5	12.86±1.72	12.53±1.69	NS	12.72±1.67	12.69±1.64	NS	12.89±1.74	12.50±1.61	NS
PBHC2	32.05±3.56	32.39±3.11	NS	31.89±3.31	32.05±3.16	NS	31.74±3.48	32.28±3.34	NS
PBHC3	14.05±2.13	13.73±1.39	NS	13.84±1.93	13.51±1.20	NS	14.00±2.09	13.49±1.36	NS
PBHC4	13.70±1.69	13.43±1.51	NS	13.57±1.65	13.34±1.38	NS	13.68±1.73	13.16±1.55	NS
PBHC5	13.60±1.72	13.32±1.53	NS	13.43±1.59	13.33±1.38	NS	13.61±1.79	13.13±1.44	NS
AISC2C3	4.21±1.18	3.71±1.08	*	4.07±1.21	3.42±1.02	*	4.21±1.16	3.53±1.11	*
AISC3C4	4.21±0.84	3.63±1.01	**	4.11±0.85	3.33±1.10	**	4.18±0.87	3.45±1.19	**
AISC4C5	4.01±0.89	3.57±0.99	*	3.88±0.86	3.39±1.07	NS	4.04±0.89	3.41±1.12	*
PISC2C3	3.08±0.75	2.92±0.86	NS	3.06±0.79	3.01±0.96	NS	3.08±0.75	2.94±0.89	NS
PISC3C4	2.84±0.88	2.85±0.88	NS	2.82±0.90	2.83±0.92	NS	2.95±0.89	2.82±0.91	NS
PISC4C5	2.98±0.95	2.86±1.00	NS	3.12±0.94	2.74±1.03	NS	3.06±0.99	2.75±0.93	NS

* p<0.05; ** p<0.01; *** p<0.001

Table 6. The impact of the vertical craniofacial parameters on the vertical cervical values measured along the line perpendicular to the FH

Variable	Parameter I			Parameter II			Parameter III		
	Group 1 (n=41)	Group 2 (n=79)	p-value	Group 1 (n=54)	Group 2 (n=33)	p-value	Group 1 (n=43)	Group 2 (n=41)	p-value
BaC4	73.56±6.26	72.46±6.35	NS	72.89±6.29	72.03±6.95	NS	73.18±6.80	71.49±6.04	NS
SC2	77.56±6.08	79.73±6.05	NS	78.50±5.59	79.36±5.92	NS	77.31±5.93	79.57±6.21	NS
SC3	95.58±7.64	96.25±6.71	NS	95.95±7.11	95.68±6.90	NS	95.31±7.54	95.48±6.78	NS
SC4	111.97±8.33	112.25±8.01	NS	112.05±7.73	111.68±8.29	NS	111.86±8.52	111.19±8.27	NS
GoC2	-1.74±5.30	4.94±6.30	***	-0.13±6.21	7.72±5.80	***	-1.42±5.65	6.24±6.31	***
PmC2	36.80±4.75	39.77±5.35	**	38.44±5.17	39.51±4.86	NS	36.86±4.69	39.35±5.14	**

* p<0.05; ** p<0.01; *** p<0.001

Table 7. The impact of sex on the cervicovertebral morphology

Variable	Male (n=60)	Female (n=60)	p-value
OPT/HOR	88.83±8.96	90.11±8.76	NS
CVT/HOR	86.00±8.58	85.06±8.26	NS
OPT/CVT	2.89±3.55	5.07±2.61	***
ABHC2	39.81±2.49	36.85±3.06	***
ABHC3	14.28±1.45	12.99±1.44	***
ABHC4	13.73±1.31	12.21±1.26	***
ABHC5	13.48±1.58	11.81±1.38	***
PBHC2	33.11±3.28	31.45±3.05	**
PBHC3	14.67±1.68	13.01±1.20	***
PBHC4	14.16±1.42	12.88±1.46	***
PBHC5	14.12±1.39	12.71±1.48	***
AISC2C3	3.94±1.14	3.82±1.14	NS
AISC3C4	3.81±1.02	3.85±0.98	NS
AISC4C5	3.81±1.02	3.62±0.93	NS
PISC2C3	3.03±0.81	2.92±0.85	NS
PISC3C4	2.84±0.93	2.85±0.81	NS
PISC4C5	3.09±1.00	2.71±0.93	*
BaC4	76.55±4.87	69.12±5.37	***
SC2	81.42±6.24	76.56±4.97	***
SC3	99.32±6.84	92.73±5.52	***
SC4	116.41±7.23	107.90±6.54	***
GoC2	1.05±6.85	4.26±6.30	**
PmC2	39.36±5.85	38.15±4.71	NS

* p<0.05; ** p<0.01; *** p<0.001

C2 (PmC2) also showed higher values in Group 2, with statistical significant differences between the groups regarding parameters I and III (p<0.01).

The impact of the gender on the cervicovertebral morphology is presented in Table 7. Statistically significant higher values in male subjects were found for the anterior and posterior body heights of all measured vertebrae (p<0.001 for ABHC2–C5 and PBHC3–C5, p<0.01 for PBHC2), the posterior intervertebral space C4–C5 (p<0.05), the total vertical dimension of the upper cervical spine (p<0.001), and the distances SC2, SC3, and SC4 (p<0.001). In females, statistically significant higher values were found for the angle OPT/CVT (p<0.001) and for the distance GoC2 (p<0.01).

In order to lower the margin of error, repeated measurements were taken during one week, by a single observer, on 20 randomly selected radiograms. Inter-observer reliability was measured using the inter-class correlation coefficient. The coefficient was high (ICC=0.986; p<0.001), which suggested high precision of measurement and low error.

DISCUSSION

The morphology of the cervical spine and the craniofacial system is related to a variety of factors [1-18]. The influence of different facial growth patterns on the cervicovertebral morphology remains unclear. In this study lateral cephalometric radiograms were analyzed in order to assess the morphology of the cervical spine in subjects with different vertical craniofacial characteristics.

In our study the subjects with anterior facial growth rotation showed the backward-inclined cervical spine (Table 4), which agrees with previous studies [11, 12]. The study of Solow and Siersbæk-Nielsen [12] showed that the backward-inclined upper cervical column (larger cervicohorizontal angles) was associated with facial development characterized by reduced backward displacement of the temporomandibular joint, increased growth in the length of the maxilla, increased maxillary and mandibular prognathism and larger than average anterior rotation of the mandible, with consequently lower anterior face height, whereas an upright position of the upper cervical column was associated with posterior facial growth rotation.

These results can be correlated with the 'soft-tissue stretching hypothesis' [19], which argues that the soft-tissue layer of facial skin and muscles is passively stretched when the head is extended in relation to the cervical column and that this stretching can lead to increased forces on the skeletal structures, which would then restrict the forward growth of the maxilla and the mandible and redirect it more caudally.

In the present study an association was found between the angulation of the cervical column (OPT/CVT angle) and the vertical craniofacial traits, as the subjects with anterior facial growth rotation showed greater cervical column curvature (Table 4). These results correlate to findings reported by Lippold et al. [10], although a different method was used for the evaluation of the cervical column curvature in that study (Fleche Cervicale).

Our results showed that the subjects with anterior facial growth rotation have a greater length of the upper cervical spine (Table 6). These findings are in accordance with the study of Karlsen [9], which assessed the association between the vertical development of the cervical spine and the face in children aged six to 15 years. The results of that study showed that children with long faces have relatively short cervical spines, while short, square faces were found in children with relatively long cervical spines, and that the vertical growth of the upper cervical spine and the face strongly correlated during puberty [9]. As our study included 17.5- to 35-year-old subjects, it can be assumed that this relationship does not change with age.

The results of this study showed that the vertical distance between the point gonion and the body of the second cervical vertebra (GoC2) has higher values in subjects with posterior facial growth rotation (Table 6). This is in agreement with the study of Karlsen [9], which showed that in children with high SN/MP angle, gonion occupies a more superior position relative to the body of C2 compared with children with a low SN/MP angle.

Our study also found an association between the distance PmC2 and the vertical facial growth pattern, as the subjects with posterior facial growth rotation showed larger values for this distance (Table 6).

Besides the cervical column as a whole, the morphology of individual cervical vertebrae showed a connection with vertical craniofacial traits as well (Table 5). The results showed that subjects with anterior facial growth rotation have greater values for the anterior (ABHC2–C5) and the posterior body heights (PBHC3–C5), except for the posterior body height of the second cervical vertebra (PBHC2). The observed difference can perhaps be explained by the fact that the morphology of this vertebra is significantly variant compared to the other measured vertebrae [20]. Looking at Table 5 it can be noticed that the values of the anterior and posterior body heights of every measured vertebra (ABHC2-C5 and PBHC2-C5) gradually decreased from higher to lower vertebrae in both groups (with anterior and posterior facial growth rotation). These results are in accordance with the results of a longitudinal study by Altan et al. [21], who found that the vertical growth of the cervical vertebrae in girls aged nine to 16 years decreases from higher to lower vertebrae, measured at the level from C2 to C4. Thus, it can be assumed that the facial growth direction (anterior or posterior rotation) does not influence this relation between the sizes of the vertebrae, as all subjects showed the same pattern. The subjects with anterior facial growth rotation showed larger anterior intervertebral spaces (C2–C5), as well as the C2–C3 and C4–C5 posterior spaces. In the available literature no article that analyzed the impact of the vertical craniofacial characteristics on the morphology of C2–C5 vertebrae was found, while the study of Kale et al. [13] showed an association between morphological deviations of the atlas vertebrae and the vertical skeletal malocclusions. Relevant literature utilized in our study was taken from the articles by Baydaş et al. [15] and Gupta et al. [4], which assessed a relationship between the vertebral morphology and sagittal skeletal growth patterns. The results reported by Baydaş et al. showed that there were statistically significant differences in the measurements of anterior and posterior body heights of C4, anterior intervertebral spaces C2–C3 and C3–C4 and the posterior intervertebral space C3–C4 between the ANB groups of subjects aged 13–15 years [13]. In accordance with this were the results by Gupta et al. [4], who found statistically significant difference in anterior intervertebral spaces C3–C4 between three ANB groups of young adult subjects.

The study of Baydaş et al. [15] showed significant gender differences in the anterior intervertebral spaces C2–C3, C3–C4, and C4–C5, posterior intervertebral space C2–C3, anterior body heights of C4 and C5 and posterior body heights of C3, C4 and C5. The results from Table 7 show higher values for the anterior and posterior body heights of all measured vertebrae (C2–C5) in males, which can be explained by the generally larger constitution of adult men compared to females. These results are in accordance with the study of Grave et al. [3] and Gupta et al. [4], which revealed that the majority of vertebral dimensions were larger in males than in females.

In our study male subjects showed higher values for the total vertical dimension of the upper cervical spine (BaC4) and the distances between the point sella and C2, C3 and C4 (SC2, SC3, SC4). The distance between the point gonion and the second cervical vertebra (GoC2) showed higher values in female subjects. These subjects also showed larger angulation of the cervical spine, which is in agreement with the research of Sonnesen et al. [1], but differs from the results reported by Tecco and Festa [2], who found that the amount of cervical curvature was not influenced by gender in subjects aged 18–51 years. In their study the cervical lordosis was measured from C2 to C7 and a different method was used for its calculation, which may be a potential reason for this discrepancy. The research of Dos Santos et al. [22] analyzed angular inclination of cervical vertebrae C1–C5 along the sagittal plane in six- to 16-year-old children. Their study found the opposite angular tendencies of vertebral growth between genders; there was a tendency towards cervical flexion (C2, C3, and C4) in girls, while a tendency towards cervical extension (C2, C3, and C4) was found in boys. These results correlate with the results of our research. The study of Sonnesen et al. [1] revealed higher cervicohorizontal angles (OPT/HOR and CVT/HOR) in females, while our results indicate that the cervical inclination is not influenced by gender.

Our and previous studies have shown that the cervical column morphology depends on the vertical and sagittal parameters of the craniofacial system, as well as the gender. Given that the different vertical facial parameters (mandibular plane angle, Jarabak's analysis and the sum of Bjork's polygon angles) describe the vertical facial growth in a different way, it was found that the number of subjects among different vertical facial growth patterns was not equally distributed regarding all three parameters (Table 3). This statement holds for both sexes. The subjects showed approximately equal distribution only for different vertical facial growth patterns determined by the sum of Bjork's polygon angles. Even though the number of subjects was not equally distributed among different vertical facial growth patterns regarding all three parameters (but only regarding the sum of Bjork's polygon angles), from Tables 4, 5, and 6 it can be noticed that all three used parameters give the same trend regarding the morphology of the cervical spine, which can confirm the fact that gender is not the only factor that influences cervicovertebral morphology.

Since this study was not a longitudinal one and because the number of subjects was relatively small, additional studies in this field are needed to clarify the relations between the two systems and thus provide a better understanding of the etiology of craniofacial disproportions, their easier and more accurate diagnosis and more efficient treatment. Given the fact that common orthodontic treatment does not affect cervicovertebral structures, future investigations have to show if closer collaboration between physical therapists and orthodontists could lead to a more successful treatment of orthodontic irregularities.

CONCLUSION

Based on the results from this study, two main conclusions can be drawn.

1. In subjects with anterior facial growth rotation, compared to posterior, the following characteristics of the cervical column may be expected: backward-inclined upper cervical spine; greater cervical column curvature; greater total vertical dimension of the upper cervical spine; shorter vertical distance between the second cervical vertebra and the points pterygomaxillare and gonion (PmC2 and GoC2); higher vertebral bodies and anterior intervertebral spaces (C2–C5).

2. In male subjects, compared to female, the following characteristics of the cervical column may be expected: smaller cervical column curvature; greater total vertical dimension of the upper cervical spine; greater vertical distances between the point sella and C2, C3 and C4 (SC2, SC3, SC4); shorter vertical distance between the second cervical vertebra and the point gonion (GoC2); higher vertebral bodies of C2–C5.

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Однос између вертикалних диспропорција краниофацијалног система и морфологије цервикалних структура код испитаника са завршеним растом

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КРАТАК САДРЖАЈ

Увод Ортодонтска дијагностика обухвата тумачење односа између краниофацијалног и цервикалног система, при чему се има у виду потенцијални утицај неправилности једног система на други.

Циљ рада Циљ ове студије био је да се испитају морфолошке одлике цервикалног дела кичменог стуба у зависности од вертикалног краниофацијалног раста и пола код испитаника са завршеним растом.

Методе рада Узорак се састојао од профилних телерендгенских снимака 120 испитаника с различитим вертикалним краниофацијалним растом, узраста од 17,5 до 35 година. На снимцима су мерени: предња и задња висина тела пршљена (*ABHC2–ABHC5*, *PBHC2–PBHC5*), висина предњег и задњег међупршљенског простора (*AISC2–C5*, *PISC2–C5*); растојање пршљенова од тачке села (*SC2*, *SC3*, *SC4*), птеригомаксиларе (*PmC2*), гонион (*GoC2*) и базион (*BaC4*); ангулација (*OPT/CVT*) и инклинација (*OPT/HOR*, *CVT/HOR*) цервикалног дела кичме.

Резултати Резултати су показали да су код испитаника с растом лица предњом ротацијом веће вредности за *BaC4*, *OPT/HOR*, *CVT/HOR*, *OPT/CVT*, предње и задње висине тела пршљенова и међупршљенских простора, док су вертикална растојања *GoC2* и *PmC2* показала мање вредности. У групи испитаника мушког пола веће вредности показале су предње и задње висине тела пршљенова, растојања *SC2*, *SC3*, *SC4* и *BaC4*. Код особа женског пола веће вредности су биле за растојање *GoC2* и угао *OPT/CVT*.

Закључак Карактеристике особа с растом лица предњом ротацијом су већа инклинација и закривљеност цервикалне кичме, веће висине вратних пршљенова и међупршљенских простора, већа дужина горњег дела цервикалне кичме и мања растојања *GoC2* и *PmC2*. Код особа мушког пола уочава се мања закривљеност цервикалне кичме, али већа висина вратних пршљенова и већа дужина горњег дела цервикалне кичме.

Кључне речи: краниофацијална морфологија; правац раста лица; вратни пршљенови

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