RESEARCH ARTICLE

Sella turcica anomalies on lateral cephalometric radiographs of Polish children

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Objectives: To assess the prevalence of sella turcica anomalies on lateral cephalograms of children with malocclusion. To describe the craniofacial morphology in patients with sella turcica anomalies.

Methods: Lateral cephalograms obtained at ages 8–16 years ($n = 431$) were assessed for good visibility of cephalometric structures, including the sella turcica, and the absence of craniofacial congenital deformities; finally, 322 cephalograms were included and analysed. Subsequently, anomalies of sella turcica have been identified. Hypertrophic posterior clinoid process, hypotrophic posterior clinoid process and oblique contour of the floor were the abnormalities found that could not be classified based on literature. The study group consisted of 151 cephalograms with abnormal sella turcica, while the control group consisted of 171 cephalograms without any sellar pathology. Data normality has been tested using Shapiro–Wilk test. Correlations with age were made using Spearman correlation coefficient and those with sex were made using independence test with Yate's correction for continuity. Mann–Whitney test was used to compare between groups and subgroups. The level of significance has been established as $p < 0.05$.

Results: Sellar anomalies were found in 151 individuals (46.9%). Statistically significant differences between patients with normal and abnormal sellar morphology were found concerning: Pg:NB ($p = 0.0009$), 1+:NA ($p = 0.0004$) and 1–:NB ($p = 0.012$), indicating a more distal position of jaw structures in subjects with abnormal sella.

Conclusions: The finding that almost 50% of children with malocclusion have sellar abnormalities confirms a general aetiology of malocclusion. Sella turcica assessment should be carried out during cephalometric analysis.

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Introduction

Lateral cephalograms are used in orthodontics to assess the craniofacial morphology, allowing to distinguish between dentoalveolar malocclusions and skeletal

discrepancies. Most changes occur between the ages of 6 and 15 years in females and between 6 and 18 years in males.¹ Apart from facial structures, fossa cranii media, including the sella turcica, are visible on radiographs. The sella turcica is the superior saddle-shaped concavity located on the intracranial surface of the sphenoid bone.² It consists four clinoid processes (two anterior and two

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Figure 1 Cephalometric landmarks used. A, the deepest point on concave contour of anterior surface of the maxilla; Ar, construction point, where the lower border of cranial base crosses the posterior contour of mandibular ramus; B, the deepest point of anterior contour of the mandible; Ba, the most posterior and inferior point of the clivus; ctg, soft-tissue point on the curve, between the nasal base and prominence of the nasal tip; d6, distal cusp of lower first molar; g6, distal cusp of upper first molar; Gn, the most inferior point of the mandibular symphysis; lia, apex of the most protruded lower central incisor; Iis, incisal edge of the most protruded lower central incisor; Isa, apex of the most protruded upper central incisor; Iis, incisal edge of the most protruded upper central incisor; N, the most anterior point of frontonasal suture; Pg, the most prominent point of the chin; Pm, posterior nasal spine or the most inferior point of the mesial wall of pterygoid fossa; S, centre of sella turcica; Sn, soft-tissue point between the nasal base and upper lip; Sp, anterior nasal spine; tgo, most distal point above the gonial angle; UL, most prominent point of the upper lip; WPg, most prominent point of the soft-tissue chin.

posterior), the anterior border represented by tuberculum sellae and the posterior border by the dorsum sellae. The anterior clinoid processes are larger and more diverse. Size and shape of clinoid processes may vary. They can be short and blunt or may protrude above the pituitary fossa, and are sometimes connected. The floor of the sella turcica is the pituitary fossa with the pituitary gland.

The sella turcica is variable in size and shape.² It can be deep or shallow in both children and adults.² Camp³ has classified normal sella turcica into three types: circular, oval or flat; circular was the most frequent, whereas flat was the least. In 70% children,

the sella turcica is round.² In profile, the sella at times has a somewhat high concave appearance caused by what appears to be an excavation beneath the anterior clinoids.² The floor of the sella turcica, which in most cases is concave, may be flat or even convex.² In lateral radiographs, the sella turcica is usually demarcated by a dense thin white line.² This feature seems to be more important than the size of the fossa.²

The development of the sella turcica is strictly associated with the development of the pituitary gland.⁴ The pituitary gland completes its development before the sella turcica is completely developed, thus, pituitary gland abnormalities modify sellar morphology. 28% of abnormalities discovered by orthodontists on lateral cephalograms are glandular anomalies, with pituitary adenoma visible as enlarged sella turcica being the most frequent.⁵

In the embryological development of the sella turcica, neural crest cells and mesodermal cells are involved. Thus, shape anomalies of the sella turcica may both be

Table 1 Cephalometric measurements according to Segner and Hasund¹²

Cephalometric value	Definition
SNA	Anteroposterior position of point A in relation to anterior cranial fossa. Clinically, this angle describes the sagittal position of the maxilla
SNB	Anteroposterior position of mandible in relation to the anterior cranial fossa
ANB	Sagittal relation between the maxilla and mandible
SNPg	Angle describing the sagittal position of the mandible
NSBa	Angle of the cranial base describing the degree of cranial base bending, for example, the relation of clivus to the anterior cranial fossa
Gn-tgo-Ar	Mandibular angle describing the inclination between the ramus and corpus of the mandible
NL-NSL	Angle describing the inclination of maxillary base to the anterior cranial fossa
ML-NSL	Angle specifying the inclination of mandibular base to the anterior cranial fossa
ML-NL	Angle describing the inclination between the bases of maxilla and mandible
H	Relationship between soft-tissue profile and hard-tissue profile
1+1-	Interincisal angle. The angle between the axes of the upper and lower central incisors
1+:NA	Axis of the upper incisors in reference to maxillary base
1-:NB	Axis of the lower incisors in reference to mandibular base
Nasolabial angle	Relationship between the upper lip and nose
Pg:NB (mm)	Distance between Pg point line between points N and B
1 + NA (mm)	Upper incisors in reference to maxillary base
1 - NB (mm)	Lower incisors in reference to mandibular base
Index	Ratio (%) between the middle and lower face heights
Wits (mm)	Distance between the perpendicular projection of points A and B on occlusal plane

Figure 2 Analysed sella turcica anomalies. (a) Normal sella turcica. (b) Sella turcica bridge type A—ribbon-like fusion. (c) Sella turcica bridge type B—extension of the clinoid processes. (d) Incomplete bridge. (e) Hypertrophic posterior clinoid process. (f) Hypotrophic posterior clinoid process. (g) Irregularity (notching) in the posterior part of the sella turcica. (h) Pyramidal shape of the dorsum sellae. (i) Double contour of the floor. (j) Oblique anterior wall. (k) Oblique contour of the floor.

accompanied by functional disorders in the pituitary gland and by morphological abnormalities of the facial bones. Kjaer⁴ concluded that abnormalities in the anterior wall of the sella turcica appear to be associated with abnormalities in the frontonasal fields and sometimes with defects in the body axis, whereas abnormalities in the posterior wall appear to be related to brain

defects. Sellar abnormalities are present in approximately half of individuals with unilateral cleft lip and palate.⁶

The most frequent abnormality described in the orthodontic literature is sella turcica bridge.^{7–11} Bridging is a fusion between the anterior and posterior structures of the sella turcica, specifically a calcification of inter-clinoid ligament⁹ or it may be owing to super-imposition

Table 2 Cephalometric values of the study group ($n = 151$)

Variable	Mean	Standard deviation	Median	Quartile 1	Quartile 3	Minimum	Maximum
SNA	79.78	5.07	80.20	77.05	82.90	41.50	90.50
SNB	77.29	4.88	77.30	74.45	80.45	50.60	89.00
ANB	2.49	3.54	2.60	0.50	5.00	−9.10	9.70
SNPg	78.13	4.79	78.10	75.30	81.30	54.50	91.30
NSBa	130.45	5.17	130.40	127.20	133.80	119.00	143.90
Gn-tgo-Ar	128.07	7.71	127.80	122.60	133.75	108.00	153.50
NL-NSL	8.58	4.97	8.70	6.50	10.90	−28.40	21.90
ML-NSL	34.43	6.07	34.30	29.50	38.65	21.30	50.40
ML-NL	25.90	6.67	25.70	21.70	29.65	3.50	56.50
H	11.27	6.80	10.90	6.65	15.75	−19.20	31.70
1 + 1−	129.06	15.35	128.10	122.20	136.75	16.60	169.60
1 + :NA angle	22.98	8.03	23.60	18.10	27.35	3.20	48.00
1 − :NB angle	25.14	8.35	25.40	20.35	30.50	−0.80	63.20
Nasolabial angle	114.32	12.32	114.70	108.45	122.40	62.00	143.10
Pg:NB (mm)	5.44	8.30	3.10	0.20	11.25	−13.40	28.70
1 + NA (mm)	12.37	13.84	10.50	1.80	20.80	−42.80	54.90
1 − NB (mm)	15.15	12.77	15.20	2.25	23.65	−12.30	63.90
Index	79.55	12.37	80.70	75.25	86.05	9.60	99.00
Wits (mm)	−3.10	19.86	−0.80	−11.30	7.00	−61.50	82.60

Table 3 Cephalometric values of the control group ($n = 171$)

Variable	Mean	Standard deviation	Median	Quartile 1	Quartile 3	Minimum	Maximum
SNA	80.38	3.77	80.40	78.50	82.35	69.00	91.30
SNB	77.41	3.88	77.60	74.90	79.68	66.30	87.30
ANB	2.96	2.92	2.85	1.20	5.05	−4.50	10.40
SNPg	78.39	3.99	78.70	75.75	80.95	67.10	88.00
NSBa	130.05	4.89	129.70	126.50	133.25	120.40	142.10
Gn-tgo-Ar	127.28	8.03	126.70	121.75	133.00	106.40	144.50
NL-NSL	8.15	3.54	7.90	6.00	10.30	0.00	21.40
ML-NSL	33.52	6.51	33.50	28.80	37.80	17.20	51.70
ML-NL	25.48	6.67	25.40	21.30	30.05	7.50	45.20
H	12.27	5.75	12.30	9.03	16.10	0.10	28.60
1 + 1 −	129.34	11.97	129.30	122.45	135.90	48.50	158.50
1 + :NA angle	24.06	12.11	23.70	18.80	28.05	6.90	151.30
1 − :NB angle	23.91	6.50	24.20	19.88	27.78	4.20	41.80
Nasolabial angle	113.62	11.16	115.40	106.05	120.55	71.40	139.40
Pg:NB (mm)	8.01	7.23	7.30	2.13	13.20	−11.70	29.30
1 + NA (mm)	17.60	14.13	17.40	8.75	26.35	−22.50	54.50
1 − NB (mm)	18.35	11.51	18.25	11.90	25.10	−11.90	50.10
Indeks	79.79	9.95	80.40	75.00	84.95	−3.60	100.10
Wits (mm)	−0.50	19.26	−0.35	−12.38	10.48	−47.80	70.90

of sellar structures.⁷ Sellar bridging has been classified by Becktor et al⁷ into two groups:

- Type A: ribbon-like fusion.
- Type B: extension of the anterior and/or the posterior clinoid process.

A partial calcification of interclinoid ligament is defined as incomplete bridge.⁹

The aim of the present study was to assess the prevalence of sella turcica anomalies on lateral cephalograms of children with malocclusion and to describe the craniofacial morphology in patients with sella turcica anomalies.

Methods and materials

After obtaining permission, 431 lateral cephalograms obtained at ages from 8 to 16 years were retrieved from the server of the Department of Radiology, Pomeranian Medical University of Szczecin, Poland, and assessed by a panel of three authors referring to the following inclusion criteria: good visibility of all cephalometric structures, including the

sella turcica, and the absence of craniofacial congenital deformities. This resulted in the final inclusion of 322 cephalograms.

Each of the selected cephalograms was analysed by a panel of three investigators, and disagreements in point identification were resolved by discussion. All cephalograms were analysed as monitor-displayed images according to Segner and Hasund,¹² using a computer program (Ortodoncja v. 7.0; Ortobajt, Wrocław, Poland). The cephalometric landmarks used have been presented in Figure 1 and the cephalometric measurements in Table 1.

Subsequently, anomalies of the sella turcica according to Axelsson et al¹³ were identified on cephalograms. In order to analyse sella bridges, the classification of Becktor et al⁷ was used. The following abnormalities were found: hypertrophic posterior clinoid process, hypotrophic posterior clinoid process and oblique contour of the floor found that could not be classified based on literature. Finally, normal sella and ten types of abnormalities identified are presented in Figure 2.

The cephalograms have been divided into two subgroups. The study group consisted of 151 cephalograms of patients with abnormal sella turcica. The control

Table 4 Prevalence of sella turcica abnormalities in the present study

Sella type	Gender						Skeletal class					
	Males		Females		Total		I		II		III	
	n = 149	%	n = 173	%	n = 322	%	n	%	n	%	n	%
Sella turcica type												
Normal	79	53.0	92	53.2	171	53.1	75	43.9	65	38.0	31	18.1
Bridge	14	9.4	24	13.9	38	11.8	16	42.1	14	36.8	8	21.1
Oblique anterior wall	7	4.7	3	1.7	10	3.1	2	20.0	6	60.0	2	20.0
Double contour of the floor	6	4.0	12	6.9	18	5.6	12	66.(6)	2	11.1	4	22.2
Pyramidal shape of dorsum sellae	15	10.1	1	0.6	16	5.0	6	37.5	7	43.8	3	18.8
Irregularity in the posterior part	7	4.7	23	13.3	30	9.3	11	36.(6)	14	46.(6)	5	16.(6)
Hypertrophic posterior clinoid processes	15	10.1	14	8.1	29	9.0	17	58.6	6	20.7	6	20.7
Hypotrophic posterior clinoid processes	4	2.7	1	0.6	5	1.56	2	40.0	2	40.0	1	20.0
Oblique contour of the floor	2	1.3	3	1.7	5	1.56	1	20.0	2	40.0	2	40.0

Table 5 Prevalence of sella turcica abnormalities in the literature

Authors		Axelsson <i>et al</i> ¹³				Alkofide ¹⁴	
Study material		72 cephalograms of healthy Norwegian individuals				180 cephalograms of Saudi individuals (60 Class I, 60 Class II, 60 Class III)	
Age range (years)		6–21				11–26	
Gender		Males		Females		n = 180	%
		n = 35	%	n = 37	%		
Sella turcica type	Normal	25	71	24	65	120	66.7
	Bridge	2	6	6	16	2	1.1
	Oblique anterior wall	8	23	1	3	17	9.4
	Double contour of the floor	0	0	1	3	16	8.9
	Pyramidal shape of dorsum sellae	0	0	2	5	5	2.8
	Irregularity in the posterior part	0	0	4	11	20	11.1
	More than one type	0	0	1	3	No data	

group consisted of 171 cephalograms of patients without any sella turcica pathology.

Data normality were tested using Shapiro–Wilk test. To assess correlations with age, the Spearman correlation coefficient was used and for correlations with sex, the independence test with Yate's correction for continuity was used. Comparisons were made between subgroups no smaller than 25 cephalograms. Mann–Whitney test was used to compare cephalometric values between groups and subgroups. The level of significance has been established as $p < 0.05$.

Results

Cephalometric values of the study and control groups have been presented in Tables 2 and 3. The prevalence

of sella turcica anomalies has been presented in Table 4. Sellar anomalies were found in 151 individuals (46.9%), including 81 females (53.6%) and 70 males (46.4%). Differences between genders were statistically insignificant.

Comparison of cephalometric values between patients with normal and abnormal sellar morphology revealed statistically significant differences concerning: Pg:NB ($p = 0.0009$), 1+:NA ($p = 0.0004$) and 1–:NB ($p = 0.012$). The highest correlation was found in the subgroup of patients with sellar bridges.

It seems that children with abnormal structure of sella, especially with sella turcica bridges are characterized by significantly higher incisor inclination angles and a more distal position of the alveolar part of the mandible. This indirectly indicates a more distal

Table 6 Prevalence of sella turcica bridge in the literature (in chronological order from earliest to most recent)

Study	Study group or material		Complete bridge		
	Number and ethnicity	Age range	Type A	Type B	Incomplete bridge
Camp ³	110 skulls of deceased people	No data	4.5% ($n = 5$) bony connection		No data
Carstens ¹⁵	461 cephalograms of healthy individuals	Young male	4.6% ($n = 21$)		No data
Busch ¹⁶	343 skulls of deceased people with no disease of pituitary glands diagnosed	No data	1.45% ($n = 5$)		1.74% ($n = 6$)
Becktor <i>et al</i> ⁷	177 cephalograms of Danish individuals with severe craniofacial deviations	No data	5.6% ($n = 10$)	13% ($n = 23$)	No data
Axelsson <i>et al</i> ¹³	72 cephalograms of healthy Norwegian individuals	6–21	11.11% ($n = 8$)		No data
Jones <i>et al</i> ⁸	150 cephalograms of English orthodontic patients	No data	2.67% ($n = 4$)	4.67% ($n = 7$)	No data
	150 cephalograms of English surgical-orthodontic patients	No data	10% ($n = 15$)	6.67% ($n = 10$)	No data
Leonardi <i>et al</i> ⁹	135 cephalograms of Italians including 101 healthy individuals (without dental anomalies) and	8–16	9.9% ($n = 10$)		33.7% ($n = 34$)
	34 adolescents with dental anomalies	8–16	17.6% ($n = 6$)		58.8% ($n = 20$)
Alkofide ¹⁴	180 cephalograms of Saudi patients with skeletal class (Class I, $n = 60$; Class II, $n = 60$; Class III, $n = 60$)	11–26	1.1% ($n = 2$)		No data
Marsan and Öztas ¹⁰	118 cephalograms of Turkish females with: Skeletal Class I ($n = 57$)	27.2 (SD, 5.3)	0%	5% ($n = 3$)	No data
	Skeletal Class III ($n = 61$)	25.8 (SD, 4.6)	0%	18% ($n = 11$)	No data
Meyer-Marcotty <i>et al</i> ¹¹	400 cephalograms of Germans with: Skeletal Class I ($n = 150$)	26.0 (SD, 7.4)	0.7% ($n = 1$)	8.7% ($n = 13$)	No data
	Skeletal Class III ($n = 250$)	24.8 (SD, 8.6)	0.4% ($n = 1$)	16.4% ($n = 41$)	No data
Present study	322 cephalograms of Polish orthodontic patients	9–16	2.2% ($n = 7$)	2.8% ($n = 9$)	6.8% ($n = 22$)

SD, standard deviation.

position of the maxillary and mandibular basal bones than in unaffected individuals.

Discussion

The size of the sella turcica was not analysed in this study; however, it is known that at the age of 8 years, the mean diameter of the sella turcica is 10 mm and at the age of 16 years, it is 11 mm. It is strictly dependent on hypophyseal morphology, thus, size alterations may be symptoms of glandular pathology and should be subjected to further diagnosis.¹³

Morphological aberrations of the sella turcica described in the literature are bridge, oblique anterior wall, double contour of the floor, irregularity (notching) in the posterior part of the dorsum sellae and pyramidal shape of the dorsum sellae.^{13,14} However, it should be remembered that the two-dimensional representation of an abnormality system does not really provide complete information about its three-dimensional structure. An infinitive number of three-dimensional sizes and shapes can yield an identical two-dimensional radiographic image, which constitutes a well proven mathematical fact inherent to two-dimensional radiography.

The frequency of all sella turcica disorders in the literature is presented in Table 5. Additional abnormalities of the sella turcica described in this study are hypertrophic posterior clinoid process, hypotrophic posterior clinoid process and oblique contour of the floor.

The frequency of sella turcica bridge in the literature has been presented in Table 6. In previous studies on healthy subjects, the occurrence of sella bridging ranged from 4.6% to 11.1%.^{11,13,15} The higher occurrence of sella turcica bridge in females in the present study supports earlier findings by Axelsson *et al.*¹³

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