Bridging of the sella turcica in skeletal Class III subjects

Philipp Meyer-Marcotty*, Tobias Reuther** and Angelika Stellzig-Eisenhauer*

Departments of *Orthodontics, and **Maxillo-Facial-Surgery and Plastic Surgery, Dental Clinic of the Medical Faculty, University of Würzburg, Germany

SUMMARY Several investigations have analysed the frequency of sella turcica anomalies in patients with severe craniofacial deviations. Until now, there have been no studies concerning the prevalence of sella turcica bridging in homogenous groups of patients. Therefore, the aims of this controlled study were to analyse the prevalence of sella turcica bridging and measure the size of the sella turcica in two well-defined groups of Caucasian individuals.

In a multicentre retrospective study, 400 pre-treatment lateral cephalograms of adult patients (over 17 years of age) with a skeletal Class III (n = 250, 132 females and 118 males) or a skeletal Class I (n = 150, 94 females and 56 males) malocclusion were analysed. The morphology, length, depth, and diameter of the sella turcica were investigated. For statistical analysis, chi-square and *t*-tests were used.

Skeletal Class III patients presented a significantly higher rate of sella turcica bridging, 16.8 per cent (P= 0.031), in comparison with skeletal Class I patients, whose rate was 9.4 per cent. No differences between females and males were detected for the length, depth, and diameter of the sella turcica. Bridging of the sella turcica could be seen radiographically in skeletal Class III subjects.

Introduction

The sella turcica is an important structure in radiographic analysis of the neurocranial and craniofacial complex. In orthodontics, the sella turcica is a significant anatomical structure because the sella point, one of the most commonly used landmarks in cephalometrics, is located at the centre of the sella turcica.

The sella turcica is situated on the intracranial surface of the body of the sphenoid bone. The anterior border of the sella turcica is represented by the tuberculum sellae and the posterior border by the dorsum sellae. The pituitary gland is surrounded by the sella turcica, whereas two anterior and two posterior clinoid processes project over the pituitary fossa. The anterior clinoid processes are formed by the medial and anterior prolongations of the lesser wing of the sphenoid bone, and the posterior clinoid processes by the endings of the dorsum sellae. During embryological development, the sella turcica area is a key point for the migration of the neural crest cells to the frontonasal and maxillary developmental fields (Kjær *et al.*, 1999).

The anatomy of the sella turcica has been described as variable (Teal, 1977). Anatomically, that author subdivided the sella turcica into three segments, consisting of an anterior wall, a floor, and a posterior wall. Morphologically, three basic types—oval, round, and flat—have been classified, the oval and round types being the most common (Figure 1).

One study, using cephalometric radiographs, has described abnormally large or, less commonly, small sella turcicas (Alkofide, 2001). The radiological diagnosis of an enlarged sella turcica has been found to be associated with adenomas, mucocele, meningioma, primary hypothyroidism, prolactinoma, gigantism, acromegaly, empty sella syndrome (non-functioning pituitary glands), and Nelson syndrome (Camp, 1923; Taveras and Wood, 1964; McLachlan *et al.*, 1970; Pribram and du Boulay, 1971; Friedland and Meazzini, 1996). Moreover, tumours such as craniopharyngioma and intrasellar aneurysm can be responsible for an enlargement of the sella turcica with bony destruction and invasion into the surrounding structures (Younghusband *et al.*, 1952). In contrast, an abnormally small sella turcica seems to be rare and found in primary hypopituitarism and Sheehan's syndrome (Pribram and du Boulay, 1971).

Additionally, bridging of the sella turcica, that is, the fusion of the anterior and posterior clinoid processes, is a further anatomical abnormality, which has been reported to occur in distinctive syndromes or skeletal and dental malformations (Childers and Wright, 1986; Koshino *et al.*, 1989; Leonardi *et al.*, 2006; Meyer-Marcotty *et al.*, 2008).

In a 'normal' population, the prevalence of a sella turcica bridge has been reported with a frequency of 1.75 to 6 per cent in anatomical and radiographic studies (Busch, 1951; Müller, 1952; Platzer, 1957). Platzer (1957) found a 5.9 per cent occurrence rate of bony sella turcica bridging by directly inspecting autopsy tissue from 220 individuals. That author assumed an association between bridging of the sella turcica and the course of the internal carotid artery.

The occurrence of a sella turcica bridge has been described as a radiographic feature in basal cell carcinoma (Gorlin– Goltz) syndrome, Rieger syndrome, and other disorders and syndromes (McLachlan *et al.*, 1970; Gorlin *et al.*, 1976; Koshino *et al.*, 1989; Meyer-Marcotty *et al.*, 2008). However, altered sella turcica morphology or bridging of the sella turcica seems to be related to a symptom of a syndrome. Meyer-Marcotty *et al.* (2008) found an



Figure 1 Classification of the three types of the sella turcica: (A) oval, (B) circular, (C) flat.

abnormal sella turcica morphology in association with a sella turcica bridge in Axenfeld–Rieger syndrome caused by uniform PITX2 mutation in all investigated patients. They concluded that these abnormal features could be primary indicators for diagnosis of Axenfeld–Rieger syndrome caused by a PITX2 mutation (Meyer-Marcotty *et al.*, 2008).

Becktor *et al.* (2000) and Jones *et al.* (2005) analysed the frequency of a sella turcica bridge in patients with severe craniofacial deviations. They found a higher prevalence of a sella turcica bridge of 18.6 and 16.7 per cent, respectively, in patients who required combined surgical–orthodontic treatment. A statistically higher incidence of sella turcica bridging was found in individuals from Saudi Arabia with Class III compared with Class I and II malocclusions (Abdel-Kader, 2007). However, the aetiology and pathogenesis of increased sella turcica bridging in patients with severe craniofacial malformations still remains to be evaluated.

To date, there have been no studies on the prevalence of sella turcica bridging in homogenous groups of patients defined by age, race, and skeletal Class. Therefore, the aims of this study were to divide Caucasian individuals into two groups based on a precise classification of their craniofacial complex, to analyse the prevalence of a sella turcica bridge, and to measure the dimensions of the sella turcica. The hypothesis was that an increased occurrence of a sella turcica bridge may be found in subjects with a skeletal Class III craniofacial complex.

Subjects and methods

Subjects

In a multicentre retrospective study approach, the pretreatment lateral cephalograms of 400 adult patients were analysed at the Department of Orthodontics of the Universities of Cologne, Heidelberg, Jena, and Würzburg.

The inclusion criteria were (1) adult patients older than 17 years of age, with growth almost complete, (2) Caucasian, (3) no history of surgical intervention in the craniofacial complex, and (4) no syndromes, clefts of the lip and palate or trauma.

Classification of the patients into skeletal Class I and skeletal Class III was performed based on ANB angle and

Wits appraisal. Patients with an ANB angle less than -1 degree and a Wits appraisal less than -2 mm were categorized as skeletal Class III, whereas those with an ANB angle 0–4 degree and a Wits appraisal ± 1 mm were categorised as skeletal Class I. Thus, two clear-cut groups of patients were generated.

- 1. Skeletal Class III: 250 patients (132 females and 118 males) with a mean age of 24.8 years [standard deviation (SD) 8.6].
- 2. Skeletal Class I (controls): 150 patients (94 females and 56 males) with a mean age of 26.0 years (SD 7.4).

Methods

The pre-treatment lateral cephalometric radiographs of all patients were taken using a standardized procedure for evaluating the cranial structures. The cephalograms were obtained with the patients in a cephalostat with ear rods and a light source for adjustment of the head position (Orthopos DS Ceph®; Siemens, Erlangen, Germany). The film-focus distance was 150 cm and the distance from the midsagittal plane to the film was 10 cm, resulting in an enlargement factor of 15 per cent. All radiographs were of good quality and showed the craniofacial complex and the anatomy of the sella turcica. The images were calibrated and all linear measurements were corrected for magnification differences prior to statistical analyses.

The analyses of the radiographs were performed by an investigator using the fr-win® software (Computer konkret AG; Dental Software, Falkenstein, Germany) to guarantee maximum consistency of the results.

Analysis of the craniofacial complex. Analysis of the craniofacial complex was based on four angular and one linear measurement on each cephalogram (Figure 2) according to Rakosi (1988). The position of the maxilla and mandible was analysed by SNA and SNB angles. The skeletal configuration was defined by ANB angle and Wits appraisal. Furthermore, the angle between the anterior and posterior cranial bases (NSBa) was measured.

Analysis of the sella turcica. Analysis of the morphology of the sella turcica was made on the radiographs. According to Becktor *et al.* (2000), the sella turcica was classified into

two groups: a sella turcica with no fusion and a sella turcica with a bridge, respectively (Figure 3). Sella turcica bridges were classified into two groups:

- 1. Type A: ribbon-like fusion.
- 2. Type B: extension of the anterior and/or posterior clinoid process, where these two meet either anteriorly, posteriorly, or in the middle, with a thinner fusion.

Measurements of the sella turcica were performed in accordance with the method of Silverman (1957) (Figure 4). All reference lines used were situated in the midsagittal plane. The sella turcica was measured by tracing the contour of the pituitary fossa from the tip of the dorsum sellae to the tuberculum sellae. The distance from the tip to the tuberculum of the sella was defined as the length. The depth of the sella was measured perpendicular to this line to the deepest point of the pituitary fossa. The greatest diameter in the sagittal direction of the sella turcica was generated from the tuberculum sellae to a point on the posterior inner contour of the pituitary fossa furthest from the tuberculum sellae. The results of the sella turcica measurements were compared with reference standards established by Axelsson *et al.* (2004).



Figure 2 Points used in the cephalometric analysis: 1, SNA (°); 2, SNB (°); 3, ANB (°); 4, Wits (mm); 5, NSBa (°).

Method error

To estimate the method error, the same investigator re-traced 20 randomly selected cephalograms after a period of 6 weeks. The method error was calculated as described by Dahlberg (1940). No significant differences were found between the first and the second measurements. The measurement errors ranged from 0.22 to 0.69 degrees and 0.10 to 0.39 mm. Thus, good reproducibility could be shown for each parameter.

Statistics

Statistical analysis was conducted using the Statistical Package for Social Science®, Version 14.0 for Windows (SPSS Inc., Chicago, Illinois, USA). First, the distribution of the data was tested using the Kolmogorov–Smirnov test, which showed a normal distribution. The cephalometric data were then analysed using an unpaired *t*-test to evaluate differences between the two groups. For analysis of the prevalence of a sella turcica bridge, the chi-square test was used. This test accounts for the numbers of examined patients regarding the difference in the sample size of the skeletal Class I and skeletal Class III groups. The significance level was set at P < 0.05.

Results

Craniofacial complex

The cephalometric measurements are shown in Table 1.

The differences between the two groups, as indicated by the ANB angle and the Wits appraisal, were highly significant (mean ANB: skeletal Class I, 2.26 degree; SD, 1.77; skeletal Class III, -2.66 degree; SD, 3.52; P < 0.001; mean Wits: skeletal Class I, 0.32 mm; SD, 1.15; skeletal Class III, -7.50 mm; SD, 4.72; P < 0.001).

The position of the maxilla, defined by SNA angle, was within the normal range in both groups according to normative data in the literature (Rakosi, 1988) (mean SNA: skeletal Class I, 79.89 degree; SD, 3.57; skeletal Class III, 80.07 degree; SD, 4.20; P = 0.651). In contrast, SNB showed significant differences. Skeletal Class III patients showed a



Figure 3 Different shapes of the sella turcica; classification according to Becktor *et al.* (2000). (a) No fusion. Sella turcica bridge: (b) Type A: manifest, ribbon-like fusion, (c) Type B: extension of the anterior and/or posterior clinoid process, where these two meet either anteriorly, posteriorly, or in the middle, with a thinner fusion.

more prognathic mandible than skeletal Class I patients (mean SNB: skeletal Class I, 77.62 degree; SD, 3.41; skeletal Class III, 82.73 degree; SD, 4.77; P < 0.001). Thus, the cephalometric data confirmed that the mandible was responsible for skeletal classification.

Additionally, the inclination of the base of the skull was slightly more pronounced in the skeletal Class III group than in the skeletal Class I group (mean NSBa: skeletal Class I, 130.23 degree; SD, 4.10; skeletal Class III, 128.94 degree; SD, 5.28; P = 0.007).

Shape of the sella turcica

Anomalies of the sella turcica were found in both groups (Table 2).

In 0.7 per cent (n = 1) of skeletal Class I patients, a manifest ribbon-like fusion of the sella turcica was detectable, while in 8.7 per cent (n = 13), extensions of the clinoid processes were evident. The overall rate of a sella turcica abnormality was thus 9.4 per cent.

Skeletal Class III patients showed a significantly higher rate of sella turcica anomalies, 16.8 per cent (P = 0.031). In 0.4 per cent (n = 1), a manifest ribbon-like fusion of the sella turcica was found. In contrast to skeletal Class I



Figure 4 Reference lines of the sella turcica according to Silverman (1957): (a) length of the sella, (b) depth of the sella, (c) greatest diameter of the sella.

 Table 1
 Cephalometric analysis of the craniofacial complex of the patients according to skeletal Class; *t*-test.

Variables	Skeletal Class I $(n = 150)$	Skeletal Class III $(n = 250)$	P value	
	Mean (SD)	Mean (SD)		
SNA (°)	79.89 (3.57)	80.07 (4.20)	0.651 n.s.	
SNB (°)	77.62 (3.41)	82.73 (4.77)	< 0.001***	
ANB (°)	2.26 (1.77)	-2.66(3.52)	< 0.001***	
Wits (mm)	0.32 (1.15)	-7.50(4.72)	< 0.001***	
NSBa (°)	130.23 (4.10)	128.94 (5.28)	0.007**	

n.s., not significant; **P < 0.01; ***P < 0.001.

patients, the frequency of an extension of the clinoid processes was increased in 16.4 per cent (n = 41) of the subjects.

Dimensions of the sella turcica

Linear measurements of the sella turcica are presented in Table 3.

No significant differences could be found between the skeletal Class I and the Class III patients concerning the length, depth, and diameter of the sella turcica.

A comparison of the measurements of females and males revealed no significant differences in terms of length, depth, and diameter of the sella turcica (Table 4).

Both patient groups presented greater sella turcica linear dimensions of length, depth, and diameter than those found in the normative data of sella turcica dimensions in adults (Axelsson *et al.*, 2004).

Discussion

In this retrospective study, the shape of the sella turcica was analysed on pre-treatment standardized lateral cephalometric radiographs in two clear-cut groups of Caucasian subjects. The purpose of this study was to examine the prevalence of a sella turcica bridge in adult patients with skeletal Class I and Class III anomalies. Furthermore, the dimensions of the

 Table 2
 Shape of the sella turcica of the patients according to their skeletal class (Becktor *et al.*, 2000); *t*-test.

Shape of the sella turcica bridge	Skeletal Class I $(n = 150)$	Skeletal Class III $(n = 250)$	P value	
Туре А				
Fusion	0.7% (1)	0.4% (1)		
Type B				
Extension of the clinoid processes	8.7% (13)	16.4% (41)		
Percentage	9.4% (14)	16.8% (42)	0.031*	

n.s., not significant. *P < 0.05.

 Table 3
 Dimensions of the sella turcica (mm) of the patients according to their skeletal class (Silverman, 1957); *t*-test.

	Skeletal Class I $(n = 150)$	Skeletal Class III $(n = 250)$	P value	
	Mean (SD)	Mean (SD)		
Length (mm) Depth (mm)	10.89 (1.62) 8.16 (1.15)	11.19 (1.65) 8.39 (1.30)	0.079 n.s. 0.079 n.s.	
Diameter (mm)	12.99 (1.55)	13.05 (1.63)	0.864 n.s.	

n.s., not significant.

	Skeletal Class I (<i>n</i> = 150)	Skeletal Class III (n = 250)	P value	Axelsson et al. (200	(n = 72)
	Mean (SD)		Mean (SD)		-	Mean (SD)	
Age	26 (7.4)		24.8 (8.6)			21.3 (0.6)	
Gender	Female $(n = 94)$	Male $(n = 56)$	Female $(n = 132)$	Male $(n = 118)$		Female $(n = 37)$	Male $(n = 35)$
Length (mm)	10.7 (1.5)	11.2 (1.7)	10.9 (1.5)	11.4 (1.7)	0.116 n.s.	8.4 (1.6)	8.9 (0.9)
Depth (mm)	8.1 (1.1)	8.3 (1.3)	8.3 (1.3)	8.5 (1.3)	0.300 n.s.	7.2 (1.2)	7.3 (1.1)
Diameter (mm)	12.9 (1.3)	13.1 (1.8)	12.9 (1.5)	13.1 (1.7)	0.306 n.s.	11.7 (1.1)	11.3 (1.1)

Table 4 Dimensions of the sella turcica (mm) of the patients according to skeletal Class and gender, *t*-test, comparison of the results with normative data of Axelsson *et al.* (2004).

n.s., not significant.

sella turcica were measured in terms of length, depth, and diameter and compared with normative data from the literature. For this reason, 400 pre-treatment lateral cephalograms of adult patients were analysed and compared in a multicentre study.

Cephalometric analyses revealed that the patients differed significantly in terms of their craniofacial complex. Whereas the sagittal position of the maxilla was similar in both groups, a significantly more prognathic mandible was found in the skeletal Class III patients. Moreover, the inclination of the base of the skull was more pronounced in the skeletal Class III than in the Class I group.

For characterization of the shape of the sella turcica, the classification published by Becktor et al. (2000) was used. The occurrence of a sella turcica bridge in individuals with a skeletal Class I was 9.3 per cent. This is consistent with previously reported data of radiographic analyses where the prevalence of a sella turcica bridge ranged from 7.3 to 9.9 per cent (Cederberg et al., 2003; Jones et al., 2005, Leonardi et al., 2006). In anatomical studies with direct inspection of autopsy tissue, the prevalence of a sella turcica bridge was found to be 1.75 to 6 per cent in males without a distinctive craniofacial anomaly (Busch, 1951; Müller, 1952; Platzer, 1957). The differences between direct anatomical studies and data from lateral cephalometric radiographs have been attributed to superimposition of the overlapping clinoid processes of the sella turcica. Therefore, only threedimensional imaging such as computed tomography or digital volume tomography could give more precise information about the sella area. However, routine use of these imaging techniques in orthodontic patients is not indicated due to the higher exposure to radiation, particularly with computed tomography. Even though lateral cephalograms are not as accurate as three-dimensional techniques to detect sella turcica anomalies, they are the only routine diagnostic tools in orthodontics to evaluate the sella turcica region. Several cases have been published in which pathological processes, such as a pituitary adenoma or prolactinoma, were discovered on lateral cephalograms during orthodontic therapy (Friedland and Meazzini, 1996; Alkofide, 2001). Therefore, the lateral cephalometric radiograph may give initial evidence of a pathology in the sella turcica region.

In contrast to the skeletal Class I group with a prevalence of a sella turcica bridge of 9.3 per cent, the skeletal Class III patients in this study presented a significantly higher rate of sella turcica bridging (16.8 per cent). The higher occurrence of a sella turcica bridge in patients with a craniofacial anomaly has been discussed in several studies. Becktor et al. (2000) examined 177 lateral cephalometric radiographs of individuals after combined orthodontic and surgical treatment. They found a sella turcica bridge in 18.6 per cent of their patients. Jones et al. (2005) reported an incidence of 16.7 per cent of sella turcica bridging in 150 patients, who also received combined surgical-orthodontic treatment. Unfortunately, neither study grouped their patients according to their skeletal anomaly. Consequently, the data of skeletal Class II patients was not evaluated separately from that of the skeletal Class III patients. Until now, the only study that analysed the prevalence of a sella turcica bridge in relation to skeletal Class was conducted in Saudi Arabia by Abdel-Kader (2007). That author found a higher percentage of sella turcica bridges in orthognathic-surgical patients with a skeletal Class III malocclusion (10.71 per cent) as well as in orthodontic patients with a Class III malocclusion (7.14 per cent). In total, the prevalence of a sella turcica bridge in 83 patients of that study with a skeletal Class III or a Class III malocclusion was 17.85 per cent. This result is consistent with the prevalence of sella turcica bridge found in the present investigation.

Additionally, by comparing the patients' linear dimensions of sella turcica with normative data from the literature (Axelsson *et al.*, 2004), it could be demonstrated in the present study that the length, depth, and diameter of the sella turcica region of all examined patients tended to be larger. No differences between females and males were observed for the length, depth, and diameter of the sella turcica. This is in agreement with the findings of Alkofide (2007), who did not find any differences in linear dimensions between the genders. In the longitudinal study of Axelsson *et al.* (2004), a significantly larger length of the sella turcica was described in the male patients from 12 to 18 years of age, but in the adult group with a mean age of 21 years, no significant difference was found between the genders. Therefore, it can be assumed that there is no difference in sella turcica size between the genders.

Conclusion

The results of this study show that the prevalence of a sella turcica bridge is significantly greater in patients with a skeletal Class III malocclusion, thus confirming the hypothesis. No differences between females and males were found for the length, depth, and diameter of the sella turcica. Bridging of the sella turcica could be seen radiographically in skeletal Class III malocclusion subjects.

Address for correspondence

Dr Philipp Meyer-Marcotty Department of Orthodontics Dental Clinic of the Medical Faculty University of Würzburg Pleicherwall 2 D-97070 Würzburg Germany E-mail: meyer_P1@klinik.uni-wuerzburg.de

References

- Abdel-Kader H M 2007 Sella turcica bridges in orthodontic and orthognathic surgery patients. A retrospective cephalometric study. Australian Orthodontic Journal 23: 30–35
- Alkofide E A 2001 Pituitary adenoma: a cephalometric finding. American Journal of Orthodontics and Dentofacial Orthopedics 120: 559–562
- Alkofide E A 2007 The shape and size of the sella turcica in skeletal Class I, Class II, and Class III Saudi subjects. European Journal of Orthodontics 29: 457–463
- Axelsson S, Storhaug K, Kjær I 2004 Post-natal size and morphology of the sella turcica. Longitudinal cephalometric standards for Norwegians between 6 and 21 years of age. European Journal of Orthodontics 26: 597–600
- Becktor J P, Einersen S, Kjær I 2000 A sella turcica bridge in subjects with severe craniofacial deviations. European Journal of Orthodontics 22: 69–74
- Busch W 1951 Die Morphologie der Sella turcica und ihre Beziehung zur Hypophyse. Virchows Archiv 320: 437–458
- Camp J D 1923 The normal and pathologic anatomy of the sella turcica as revealed at necropsy. Radiology 1: 65–73

- Cederberg R A, Benson B W, Nunn M, English J D 2003 Calcification of the interclinoid and petroclinoid ligaments of sella turcica: a radiographic study of the prevalence. Orthodontics & Craniofacial Research 6: 227–232
- Childers N K, Wright J T 1986 Dental and craniofacial anomalies of Axenfeld- Rieger syndrome. Journal of Oral Pathology 15: 534–539
- Dahlberg G 1940 Statistical methods for medical and biological students. Interscience Publications, New York
- Friedland B, Meazzini C 1996 Incidental finding of an enlarged sella turcica on a lateral cephalogram. American Journal of Orthodontics and Dentofacial Orthopedics 110: 508–512
- Gorlin R J, Pinborg J J, Cohen M M 1976 Syndromes of the head and neck, 2nd edn. McGraw-Hill, New York, pp. 649–651
- Jones R M, Faqir A, Millett D T, Moos K F, McHugh S 2005 Bridging and dimensions of sella turcica in subjects treated by surgical-orthodontic means or orthodontics only. The Angle Orthodontist 75: 714–718
- Kjær I, Keeling J W, Fischer-Hansen B 1999 The prenatal human cranium—normal and pathologic development. Munksgard, Copenhagen
- Koshino T, Konno T, Ohzeki T 1989 Bone and joint manifestations of Rieger's syndrome: a report of a family. Journal of Pediatric Orthopedics 9: 224–230
- Leonardi R, Barbato E, Vichi M, Caltabiano M 2006 A sella turcica bridge in subjects with dental anomalies. European Journal of Orthodontics 28: 580–585
- McLachlan M S, Wright A D, Doyle F H 1970 Plain film and tomographic assessment of the pituitary fossa in 140 acromegalic patients. British Journal of Radiology 43: 360–369
- Meyer-Marcotty P, Weisschuh N, Dressler P, Hartmann J, Stellzig-Eisenhauer A 2008 Morphology of the sella turcica in Axenfeld-Rieger syndrome with PITX2 mutation. Journal of Oral Pathology & Medicine 37: 504–510
- Müller F 1952 Die Bedeutung der Sellabrücke für das Auge. Klinische Monatsblätter für Augenheilkunde 120: 298–302
- Platzer W 1957 Zur Anatomie der Sellabrücke und ihrer Beziehung zur A. carotis interna. Fortschritte auf dem Gebiet der Roentgenstrahlen und der Nuklearmedizin 87: 613–616
- Pribram H W, du Boulay G H 1971 Sella turcica. In: Newton T H, Potts G P (eds). Radiology of skull and brain. vol. 1: The C.V. Mosby Company, St Louis, pp. 357–390
- Rakosi T 1988 Atlas und Anleitung zur praktischen Fernröntgenanalyse. Hanser, München, Germany
- Silverman F N 1957 Roentgen standards for size of the pituitary fossa from infancy through adolescence. American Journal of Roentgenology 78: 451–460
- Taveras J M, Wood E H 1964 Diagnostic neuroradiology. Williams and Wilkins Co., Baltimore
- Teal J S 1977 Radiology of the adult sella turcica. Bulletin of the Los Angeles Neurological Society 42: 111–174
- Younghusband O Z, Horrax G, Hurxthal L M 1952 Chromophobe pituitary tumors. Journal of Clinical Endocrinology and Metabolism 12: 611–616

Copyright of European Journal of Orthodontics is the property of Oxford University Press / UK and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.