



Comparing dimensions of sella turcica obtain by x-ray method and morphometry of dry human skulls

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ARTICLE HISTORY

Received: 31.03.2014

Accepted: 25.04.2014

Available online: 30.08.2014

Keywords:

Sella turcica, Sella dimensions, Sella area.

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ABSTRACT

A deviation from normal size and shape of sella turcica can be an indication of a pathological condition of the pituitary gland. Most of the studies has been conducted on radio- graphical methods (X-ray and MRI) and few other studies also been reported on cadavers ,but to our knowledge no previous study has compared the dimensions of sella turcica on X-ray films and dry skull bones simultaneously on the same specimens. A total 15 dry human skulls with the intact sella turcica of unknown age and sex of north Indian origin were used. Measurements were firstly taken on dry skulls and the same specimens were subjected to X-rays. All the measurements were taken in according to three different methods (A, B & C) formulated for the two different materials for the radiographic films (A, B) and dry human skulls(C).The statistical analysis was done by SPSS 19.0 version.The mean values for AP-Length was found as 19.7 ± 2.3 , 9.0 ± 1.7 and 10.2 ± 1.2 mm respectively for methods A, B & C. The depth was recorded as 4.6 ± 0.9 , 6.29 ± 1.1 and 7.6 ± 1.3 mm for methods A, B & C. The area of sella calculated as 92.5 ± 21.6 , 56.2 ± 13.6 and 77.4 ± 12.9 mm² for methods A, B & C respectively.The calculated area for sella turcica on X-Ray films is greater than the area calculated by measuring the dry skull bones. There has been variation in the measurement taken on radiographs by different reference points and methods.

INTRODUCTION

Anatomically sella turcica is a saddle shaped depression in sphenoid bone which contains the pituitary gland. On a lateral cephalometric radiograph the image of sella turcica is U shaped. A deviation from normal size and shape of sella turcica can be an indication of a pathological condition of the gland[1].The sella anatomy is variable and has been classified into three types round, oval, or flat[2]. The accepted normal maximum dimensions of 16 mm in antero-posterior dimension and 12 mm in depth. Normal sella turcica volume has been stated to be 133 mm³[3].

In another study normal sellar area was reported as 130 mm² [2] at a 28-inch anode-to-film distance and also has been stated that sellar volume is a more reliable indicator of sellar size than merely measuring the height and width[4-5]

Previously a study[6] on 100 prenatal and 64 postnatal cadavers has been conducted which reported the mean length in post-natal cadavers was 9.6 ± 1.5 mm and the mean depth was 9.05 ± 1.0 mm, also has been stated that various sella turcica

parameters in pre and postnatal cadavers did not reveal statistically significant differences between different age groups but with reference to sex it revealed that only sella turcica depth was significant in different age groups whereas the other parameters were not significant in both pre and post-natal cadavers.

The variability of the earlier reported[7] results is impressive, thus the length of the sella varies 5- 16 mm, the width 9- 18 mm, the depth 4-13 mm and the volume between 240-1150 mm³[3].

All the anatomical details concerning the possible variants of the sellar region must be taken into account by neurosurgeons in order to decide which approach (transfrontal, transethmoidal, transsphenoidal sublabian or endonasal) is to be chosen. For this reason, neurosurgeons also perform anatomical studies on cadaveric specimens or dry skulls in order to obtain the additional information required[8-9].

According to Yassir A et al[10] all the linear measurements on sample of 130 lateral cephalometric radiographs the sella turcica were within standard range. Neither gender nor skeletal patterns

showed significant differences in sella turcica linear measurements. They found normal morphology of the sella turcica in the majority of subjects.

Most of the studies have been conducted on radio-graphical methods (X-ray and MRI) and few other studies also been reported on cadavers, but to our knowledge no previous study has compared the dimensions of sella turcica on X-ray films and dry skull bones simultaneously on the same specimens. As this is not possible for the direct measurements of sella turcica on living patients, their by only radiographical method is the only method for assessment of sellar region anatomy. As this region is very important to neuro- surgeons its dimensions must be accurate and close to the in-vivo conditions, for that reason, present study was designed taking three different methods to bring the sellar parameters measured on X-ray films shall be close to actual bony dimensions in north Indian subjects. No previous study has compared the dimensions of sella turcica on X-ray films and dry skull bones simultaneously on the same specimens. The study targets to estimate the sellar dimensions by various methods applied on X-Ray films and dry skull bones.

MATERIALS AND METHODS

In the present study a total 15 dry human skulls with the intact sella turcica of unknown age and sex of north Indian origin were collected from the department of anatomy S P Medical College, Bikaner, Rajasthan, for the measurements of the sella turcica. Measurements were firstly taken on dry skulls and the same specimen were subjected to X-rays so that the lateral cephalogram would be taken in a way that the distance of X ray source which was kept at a fixed distance of 60 cm from all the specimen should remain fix and the radiographic film taken should remain of the same magnification. The measurements were taken on the radiographic films and dry skulls with the help of a vernier calipers and depth gauge, those were calibrated to measure up to the tenth fraction of millimeter. All the measurements were recorded in millimeters and were taken thrice by single observer then the mean was calculated.

All the measurements were taken in according to three different methods (A, B & C) formulated for the two different materials for the radiographic films and the dry human skulls. The dimensions of the sella turcica those were measured on

radiographic films, labeled as methods A & B considering two different approaches reported previously. [11]

Following measurements taken for Method-A (X-Rays):-

AP- Length of sella turcica:- measured in between two points which were taken at the superior aspect of dorsum sellae and other at the superior aspect of tuberculum sellae. Fig-1

Depth of sella turcica:- greatest measurement taken at the line drawn perpendicular from the AP- Length to base of sella turcica.

Interclinoid distance:- the shortest distance between the clinoid processes.

Following measurements taken for Method-B (X-Rays):-

AP- Length of sella turcica:- the length was measured as the linier distance from the tuberculum sellae to the tip of posterior clinoid process. Fig-2

Depth of sella turcica:- deepest measurement taken at the line drawn perpendicular from the AP- Length to base of sella turcica.

Antero-posterior diagonal (AP Diagonal) diameter:- was measured from the tip of tuberculum sellae to the furthest point on the posterior inner wall of the fossa.

Interclinoid distance:- the shortest distance between the clinoid processes.

Following measurements taken for Method-C (Dry Skulls):-

AP- Length of sella turcica:- the length was measured as the linier distance from the tuberculum sellae to the tip of dorsum sellae.

Depth of sella turcica:- deepest measurement taken perpendicular from the AP- Length to base of sella turcica.

Antero-posterior diagonal (AP Diagonal) diameter:- was measured from the tip of tuberculum sellae to the furthest point on the posterior inner wall of the fossa.

Interclinoid distance:- the shortest distance between the clinoid processes.

Width of the sella turcica :- was measured in coronal plane at

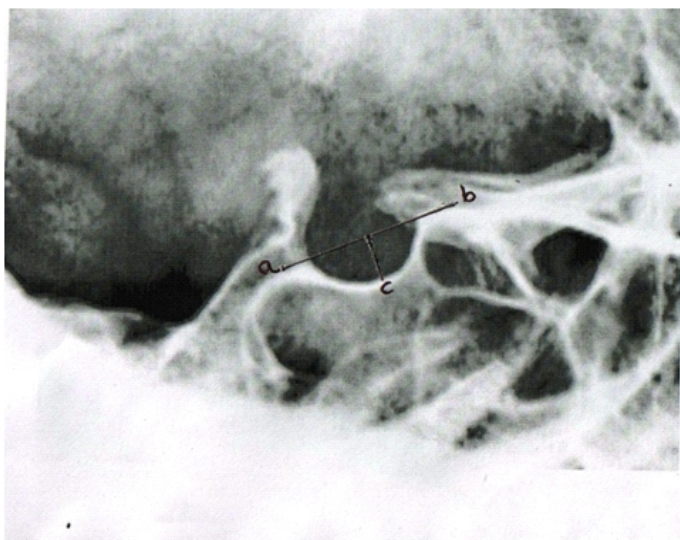


Fig. 1. Measurements according to Method A.

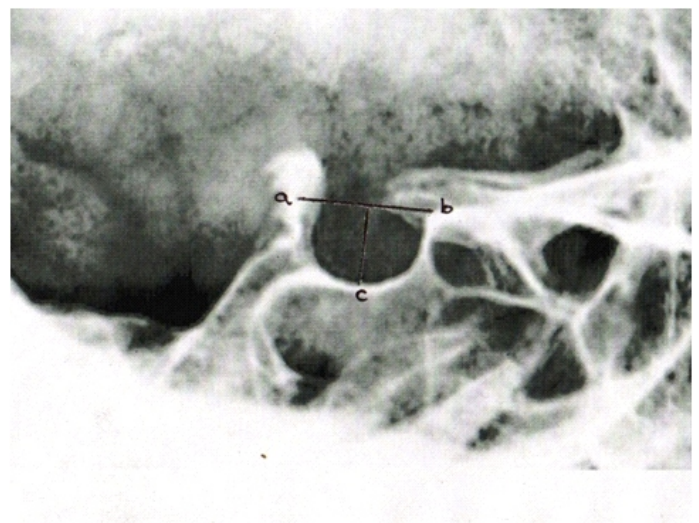


Fig. 2. Measurements according to Method B.

Table 1. Descriptive Statistics

Methods	Parameters	Minimum	Maximum	Mean		Std.
		Statistic	Statistic	Statistic	Std. Error	Deviation Statistic
Method-A (X-ray)	AP-Length	14.75	23.35	19.7946	.60982	2.36182
	Depth	2.45	5.92	4.6748	.23786	.92125
	Area	53.05	123.72	92.5449	5.59710	21.67749
	Inter Clinoid Distance	1.67	5.87	4.0467	.38928	1.50766
Method-B (X-ray)	AP-Length	6.02	11.40	9.0142	.44561	1.72583
	Depth	4.31	8.34	6.2991	.30035	1.16325
	Area	36.49	84.04	56.2847	3.52820	13.66468
	Inter Clinoid Distance	1.67	5.87	4.0467	.38928	1.50766
	AP Diagonal	9.35	14.29	11.7543	.36057	1.39648
Method-C (Dry Skulls)	AP-Length	8.50	11.90	10.2067	.31870	1.23431
	Depth	5.20	10.40	7.6533	.35882	1.38969
	Area	48.45	93.24	77.4733	3.33748	12.92599
	Inter Clinoid Distance	1.80	9.40	6.1333	.38245	2.150434
	AP Diagonal	10.10	14.40	12.4533	.35882	1.38969
	Width	9.20	15.10	12.4267	.45486	1.76168

All the measurements in mm.

the floor of the fossa, greatest distance between medial margins of the internal carotid arteries.

In all above methods the area of the sella turcica was calculated by multiplying the AP Length of sella to the Depth of the sella turcica.

All the statistical analysis was done by SPSS 19.0 version. The measurements were taken on dry skulls and the cephalograms thus be compared in two different methods and the optimum area of the sella turcica to be calculated.

RESULTS

Sella turcica dimensions according to Method-A:-

The Antero-posterior length (AP Length) of the sella turcica was obtained in a range of 14.7mm to 23.3 mm and the mean value was found as 19.79 ± 2.36 mm.(Table-1)

The depth of the sella turcica was found in a range of 2.4mm to 5.9mm and the mean value was obtained as 4.67 ± 0.92 mm. The area calculated was in a range from 53.0 mm^2 to 123.7 mm^2 and the mean value as $92.54 \pm 21.6 \text{ mm}^2$.

Interclinoid distance was measured as 1.6mm to 5.8mm for the

range and the mean was found 4.0 ± 1.5 mm.

Sella turcica dimensions according to Method- B:-

The Antero-posterior length (AP Length) of the sella turcica was measured in a range of 6.0 mm to 11.4 mm. The mean value found as 9.0 ± 1.72 mm. (Table-1)

The depth of the sella turcica recorded as in range of 4.3mm to 8.3mm and the mean value was obtained as 6.29 ± 1.16 mm further the area calculated as for the range of 36.4 mm^2 to 84.0 mm^2 and the mean value for this as $56.2 \pm 13.6 \text{ mm}^2$. Antero-posterior diagonal (AP Diagonal) distance was measured as 9.3mm to 14.2mm for the range and the mean was found 11.7 ± 1.39 mm. Interclinoid distance was measured as 1.6mm to 5.8mm for the range and the mean was found 4.0 ± 1.5 mm.

Sella turcica dimensions according to Method- C:-

The range of Antero-posterior length (AP Length) of the sella turcica was recorded as 8.5mm to 11.9 mm. and the mean value for the same was 10.2 ± 1.23 mm. (Table-1)

The depth of the sella turcica was found in a range of 5.2mm to 10.4mm and the mean value was obtained as 7.65 ± 1.38 mm. The

area calculated was in a range from 48.4 mm² to 93.2 mm² and the mean value as 77.47±12.92 mm².

The width of the sella seen as in a range 9.2mm to 15.1mm and the mean for that was 12.4 ±1.76mm. Interclinoid distance was measured for the right side as 1.8mm to 8.8 mm and left side 2.2mm to 9.4mm for the range and the mean values were found as 5.87±2.16 mm for right and 6.39±2.18mm for left sides. As there was no significant difference observed hence the data for the right and left sides were pooled and the common mean value was found as 6.13±2.15mm. Antero-posterior diagonal (AP Diagonal) distance was measured as 10.1mm to 14.4mm for the range and the mean was found 12.4±1.38mm. The area of the sella turcica as recorded by three different methods in this present study shows significant differences. When compared the mean values of the area by method B&C the difference was less as compared to difference between methods A&C.

The correlation of the area of the sella turcica was analyzed and the correlation among various methods between dimensions assessed. The area calculated from method A was significantly correlated to the AP-Length and depth (p-values 0.05 and 0.0001 respectively), similarly the area from method B was also significantly correlated to the length, depth and diagonal diameter (p-values 0.004, 0.03 and 0.02 respectively). In method C the area was also significantly correlated to the depth and diagonal length except AP-Length (p-values 0.001 and 0.01 respectively). As seen through all these methods the depth was strongly correlated to the area calculated.

DISCUSSION

The linear dimensions (length, depth and diameter) of sella turcica showed differences between measurements among previous studies. A cadaveric study[7] showed that the average width of sella turcica was 12 mm, length (anteroposterior diameter) was 8 mm and height (vertical diameter) was 6 mm. They also postulated that the height of sella turcica was 2 mm shorter than the width which infers that the gland does not fill the whole volume of sella turcica. The size of sella turcica was assessed in a Norwegian sample longitudinally between the ages of 6 to 21 years and findings were that the length was almost constant throughout the observation period where as the depth and diameter increased with age. In the same study it was also found that there was no significant difference in depth and diameter between males and females while the length was larger in males[12]. When our results were compared with the Norwegian sample, the difference in the linear dimensions length and depth were between 10.3 and 3.8 mm for method A (X-ray) and 0.4mm and 2.2mm for method-B (X-ray) and 0.8mm and 0.8mm for method-C (Dry skull) thus the difference in dimensions were less in method-B and C. In Comparison to Alkofide[13] results shows that linear dimensions in the Indian population sample taken by method-B from present study were on average 1.7 to 2.9 mm smaller than those of the Saudi subjects.

Patients above 15 years from Islamabad was studied[14] and the size and shape of sella turcica reported for mean length and Antero-posterior diagonal diameter in females was 11.3 and 14 mm and in males it was 11.4 and 13.8 mm. The mean depth in both the genders was 9.9 mm. The authors concluded that there was no statistically significant difference among all three linear measurements in both genders and in different skeletal patterns. When compared with present study the dimensions were smaller up to 2.3mm for AP-length and 3.7mm for depth according to method B and values were equal to the values taken by method-C.

Filipovic et al[15] analyzed the size of the sella turcica in 90 Nisi subjects between the age group of 18 to 22 years and found that the length, width and antero-posterior diagonal diameter was 9.2, 8.3 and 10.9 mm respectively. The authors concluded that there was no difference between the two sexes. Comparison of the size with our study population shows that the lengths were similar for method-B & C where as depth and diameter was larger in nisi subjects. The probable reasons for these differences in the values can be attributed to ethnicity or in the method of measurements.

A study done by Israel H et al[16] which showed that the size of sella was almost the same in males (88.1 to 106.4mm²) and females (88.3 to 97.6mm²) but the size tends to increase in males with age. When compared the values for area of sella to the present study method-B were greater in male and female both up to 35% approximately. Whereas when these values were compared with the values taken by method-A in present study (92.5mm²) showed no difference.

Silverman F N et al[17] studied the radiographs of 320 subjects from 1 month to 18 years of age and calculated the mean sella area. The findings were as pituitary fossa found larger in males than in females from 1 to 13 years of age. Since the pubertal growth spurt occurs approximately 2 years earlier in females than in males, the size increases from 11 to 15 years of age. The size of the sella becomes equal in both genders due to the late pubertal growth spurt in males by 2 to 3 years.

Haas LL¹⁸ studied the mean sella area in males and in females of 3 to 17 years of age and reported that the size was slightly larger in boys than in girls up to 17 years after which the size was greater in females. In this study, when the area of sella was compared, the size was greater in method-A than in the method-C&B. The area of the sella was found as 92.5mm², 56.2mm² and 77.4mm² for the Methods-A, B&C respectively. There are few other studies in the literature which have evaluated the relationship between the size of sella turcica and skeletal type as in the study done by Sathyanarayan H P et al[19] the size of sella turcica was larger in skeletal Class III subjects. Alkofide¹³ found that the size was smaller in skeletal Class II subjects and larger in skeletal Class III subjects. Sathyanarayana H P et al[19] reported that when age, gender and skeletal type were compared to the size of sella turcica, age was significantly related to the length of sella, size being larger in older group than in younger group irrespective of gender and skeletal type.

The dimensions of the sella were also reported by Jones R M et al[20] they studied the two different study groups combined surgical-orthodontic group and orthodontics-only group in which he has taken linear dimensions similar to method-A and reported the AP Length as 10.2mm and 10.0mm respectively, depth as 8.6mm in both groups, diagonal diameter as 10.2mm and 10.0mm respectively, The inter-clinoid distance was reported as 3.5mm and 4.1 mm. The area of the sella was reported as 69.1mm² and 65.2mm². Our AP Length was 19.8mm and 9.0mm for methods-A&B respectively which is similar. (Table-1) The depth of the sella was 8.6mm in Method C which is more close to the values reported above. Our area values taken by method-B&C were close to the values reported in above study[20]. The interclinoid distance values were similar in both the studies. Subhadra devi et al[6] has reported AP length and depth in 64 postnatal cadavers aged from 11 to 70 years. The values for length (9.6mm) has no variation in male and females and also compared to our study values were similar take by method-B&C. depth (9.05mm) also similar to the depth recorded by method-C (7.6mm).

Saad A et al[11] has reported the the AP-length, depth and Area of sella turcica on class-1 and 2 cases thus no significant difference between parameters. Compared to present study method -A the AP-length and area was found more where as the depth was found less and method C values showed great level of difference. That may be due to taking different points of liner measurements which are suppose to be more accurate because taken on dry skull bones. The method of Saad A et al on x-ray films overestimate the AP-Length so when measuring the AP-length the tip of the dorsum sellae shall be considered as the more accurate point for that as taken in the method B of the present study. In the present study when compared the mean values of the area by method B&C the difference was less as compared to difference between methods A&C. the possible reason for the difference may be the measurement taken for the AP-Length in method A is far greater as it was taken on x-ray films from point superior aspect of dorsum sellae that is very vague to find due to overshadowed by posterior clinoid processes. We recorded the AP-Length in method A as reported in study[13]and our findings were similar to them. For the reference purpose when we took the AP-length measurement on dry skulls and the area was calculated the values for length and areas were far less compared to method A. Further we also recorded the AP-length as stated by Shah[16] from the point at the tip of the dorsum sellae which is more close to the measurements taken on dry skulls as in method C.

CONCLUSION

The present study was an effort to estimate the more accurate dimensions of sella turcica on x-ray films by comparing the reference lines and landmarks of X-Ray images to the dry bone sellar landmarks and further readjusting these reference lines and landmarks on x-ray films in accordance to the dry skull dimensions.

ACKNOWLEDGEMENT

We are thankful to the Department of anatomy, S P Medical College, Bikaner for cooperation to conduct this study.

REFERENCES

1. Andredaki M, Koumantanou A, Dorotheou D, Halazonetis DJ. A cephalometric morphometric study of the sella turcica. *Eur J Orthod.*2007;29:449-56.
2. Camp JD II. The normal and pathologic anatomy of the sella turcica as revealed by roentgenograms. *Am J Roentgen.*1924;12:143-56.
3. Friedland B, Meazzini C. Incidental finding of an enlarged sella turcica on a lateral cephalogram. *Am J Orthod Dentofacial Orthop.*1996;110:508-512.
4. Hare HF, Silveus E, Smedal MI. Roentgenologic diagnosis of pituitary tumors. *Radiology.*1949;52:193-8.
5. Fisher RL, Di Chiro GH. The small sella turcica. *Am J Roentgen.*1964;91:996-1008.
6. Subhadra Devi V, Baburao S. Age and sex related morphology and morphometry of sellar region of sphenoid in prenatal and postnatal human cadavers. *Int J Res Dev Health.*2013;1(3):1418.
7. Quaknine GE, Hardy J. Microsurgical anatomy of the pituitary gland and the sellar region: 2. The bony structures. *Am Surg.*1987;53:291-297.
8. Renn WH, Rhoton AL. Microsurgical anatomy of the sellar

- region. *J Neurosurg.*1975;43:288-298.
9. Romano A, Zuccarello M, van Loveren HR, Keller JT. Expanding the boundaries of the transsphenoidal approach: A microanatomic study. *Clin Anat.*2001;14:19.
10. Yassir A, Mohammed N, Hadeel A. Size and Morphology of Sella Turcica in Iraqi Adults. *Size and Morphology of Sella Turcica in Iraqi Adults.*2010;7(1):23-30.
11. Asad S, Hamid W. Assessment and comparison of dimensions of Sella turcica in skeletal class I & skeletal class II cases. *Pak Oral Dental J.*2005;25:59-64.
12. Axelsson S, Storhaug K, Kjaer I. Post-natal size and morphology of the sella turcica in Williams syndrome. *Eur J Orthod.*2004;26:613-21.
13. Alkofide EA. The shape and size of the sella turcica in skeletal class I, II, and III Saudi subjects. *Eur J Orthod.*2007;29:457-463.
14. Shah AM, Bashir U, Ilyas T. The shape and size of the sella turcica in skeletal class I, II & III in patients presenting at islamic international dental hospital, Islamabad, Pakistan *Oral & Dental Journal.*2011;31(1):104-10.
15. Filipovic G, Buric M, Janošević M, Stosic M. Radiological measuring of sella turcica's size in different malocclusions. *Acta Stomatologica Naissi.*2011;27:1035-1042.
16. Israel H. Continuing growth in sella turcica with age. *Am J Roentgenol Radium Ther Nucl Med.*1970;108:516-527.
17. Silverman FN. Roentgen standards for size of the pituitary fossa from infancy through adolescence. *Am J Roentgenol.*1957;78(3):45-60.
18. Haas LL. The size of the sella turcica by age and sex. *Am J Roentgenol Radium Ther Nucl Med.*1954;72:754-761.
19. Sathyanarayana HP, Kailasam V, Chitharanjan AB. The Size and Morphology of Sella Turcica in Different Skeletal Patterns among South Indian Population: A Lateral Cephalometric Study. *J Ind Orthod Soc.*2013;47(4):266-271.
20. Jones RM, Faqir A, Millett DT, Moos KF, McHugh S. Bridging and dimensions of sella turcica in subjects treated by surgical orthodontic means or orthodontics only. *Angle Orthod.*2005;75:714-718.