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Age and sex related morphology and morphometry of sellar region of sphenoid in prenatal and postnatal human cadavers

ANATOMY

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ABSTRACT

Sella turcica is a saddle shaped depression in the body of sphenoid bone in middle cranial fossa. The pituitary gland is located in the depression of sella known as hypophyseal fossa. Sella turcica is an important anatomical structure for cephalometric assessment. The sella is roofed by a fold of dura known as diaphragm sellae with an aperture in its centre for the passage of pituitary stalk. A study on 100 prenatal and 64 postnatal cadavers was conducted with an objective to establish certain morphological and morphometric parameters of sella turcica, optic chiasma, diaphragma sellae and opening of diahphragma sellae for passage of pituitary stalk in local population of different ages and both sexes as a reflection for Indian population. Knowledge of anatomy of sellar region and its variations are important for neurosurgeons to avoid damage to the structures in and around sella.

***Key words:* Diaphragm sellae, Optic chiasma, Pituitary stalk, Sella turcica.**

Introduction

Sella turcica is a saddle shaped depression in the sphenoid bone. It received its name from its resemblance to the Turkish saddle. The seat of the saddle is known as pituitary fossa or hypophyseal fossa. The pituitary gland or hypophysis cerebri is situated in the hypophyseal fossa. It is limited anteriorly, posteriorly and inferiorly by bony constituents of the sella turcica the tuberculum sellae, dorsum sellae and bony roof of sphenoid air sinus respectively [1, 2]. The superior aspect of the pituitary gland is covered by the thin layer of dura known as diaphragma sellae which is pierced centrally by an aperture for pituitary stalk.

Thorough knowledge on anatomy of sellar region, including diaphragma sellae, optic chiasma and pituitary stalk, is important to neurologists and neurosurgeons dealing with pathologies in this region. Recognizing variations is important in preventing damage during surgery [3].

Four different positions for pituitary stalk were reported in literature [3].They are anterior where it is close to tuberculum sellae; mid position that is central to diaphragm sellae; a posterior position where it is close to dorsum sellae; and a prominent tuberculum sellae.

Three different relationships between the optic chiasm and its surrounding structures including the tuberculum sellae, diaphragma sellae, dorsum sellae and the pituitary gland were described in literature [3, 4]. They are the prefix type, in which the optic chiasm is located on top of the tuberculum sellae. The second one is the normal, in which the optic chiasm is located on the top of diaphragma sellae. The third type is known as the postfix variety where the optic chiasma is located on top of the dorsum sellae.

Diaphragma sellae is a small, circular, horizontal fold that forms roof of pituitary. When viewed from above, the superior surface of diaphragma sellae has 3 different shapes: convex, concave, and flat [3, 4]. Diaphragma sella consists of a central aperture of variable size, ranging from small foramen to a large hole and transmits the pituitary stalk and its blood vessels. The size of the aperture is important in protecting the gland from transmitted pulsations of the choroid plexus or in defending the visual fibers against suprasellar extension of an expanding pituitary tumor [5].

The importance of understanding the anatomic variations in the sellar region and the influence of these variations on surgical approach had been described in literature [4, 6]. The morphometric study of central aperture of diaphragma sellae may help to prevent the cerebrospinal fluid leak, optic nerve injury, or other brain tissue injuries [2].

There are no reports on morphological and morphometric parameters of structures around hypophyseal fossa and on morphometric parameters of diaphragm sellae and sella turcica in foetal and none on adult Indian population.

Materials & Methods

A total of 164 sella turcica of different ages (100 prenatal and 64 postnatal) and both sexes of dead aborted foetuses and adult cadavers in Forensic autopsies were studied after obtaining informed consent from the close kith and kin of the deceased. The study was approved by institutional ethics committee.

Formalin (10%) was injected into thoracic, abdominal and orbital cavities of prenatal cadavers. After preservation, the cranial cavity was opened and the brain was removed. Removal of brain exposes the pituitary gland roofed by diaphragma sellae at its margins. For postnatal cadavers the sellar region was observed after removal of brain during autopsies. The position of pituitary stalk, optic chiasma, shape of diaphragm sellae and central opening were observed. By using Digimatic calipers (Vernier-Digital-MHUtoyo 6”Mitutoyo) sellar opening transverse diameter (SOTR) and sellar opening antero-posterior diameter (SOAP) were recorded in millimeters. After careful removal of the pituitary gland along with its stalk the length of sella turcica (STL) is obtained by measuring the distance between the tuberculum sellae to dorsum sellae. The depth of sella turcica (STD) is measured at the deepest part of sella and is at right angles to the direction of length of sella turcica (STL). All the measurements were recorded in centimeters.

Results

In the present study a total of 100 prenatal and 64 postnatal cadavers of both sexes and different age groups (Table: 1) were utilised. Pre and post-natal groups were further subdivided in to 6 groups each (A-F).

Three different positions of stalk of pituitary gland in relation to tuberculum sellae, dorsum sellae and diaphragma sella were observed. They are anterior, mid and posterior. The Percentage incidence of mid position of pituitary stalk is higher followed by posterior and anterior positions in both pre and postnatal groups (Table: 2).

Three different positions of pre-fixed, post-fixed and normal of optic chiasma were observed in the present study (Table: 3). The percentage incidence of normal position was highest in both pre and postnatal cadavers. The percentage incidence of post-fixed is the next highest followed by pre-fixed.

Three different shapes of diaphragm sellae were observed and analysed sex-wise in the pre and post-natal cadavers in the present study (Table: 4). The shape of sellar opening was either elliptical or round (Table: 5) with a higher incidence of round shape when compared to elliptical. One way ANOVA test for sella turcica and diaphragma sella parameters of aborted foetuses (Table: 6) in the sample studied in various gestational age groups reveals that all the parameters are highly statistically significant with gestational age.

One way ANOVA carried out for various sella turcica and diaphragma sella parameters in foetuses with reference to sex (Table: 7) reveals that only sella turcica depth is significant in different age groups with reference to sex whereas the other parameters are not significant. One way ANOVA carried out for various sella turcica and diaphragma sella parameters in post-natal sample of various age groups (Table: 8) reveals that only sellar opening transverse diameter is significant with age. The remaining parameters are not significant. One way ANOVA carried out for various sella turcica and diaphragma sella parameters in post-natal cadavers with reference to sex (Table: 9) reveals that only sella turcica depth is significant in different age groups with reference to sex whereas the other parameters are not significant.

Discussion

The entire developmental spectrum of sella turcica, diaphragm sellae, optic chiasma and pituitary stalk from fetal to old age has not been reported in the literature. This study on 164 cadavers is the first to report on morphology and morphometry of sella turcica and nearby structures of 12 weeks of gestational age to 70 years of postnatal period on a large sample.

The common anatomic position of pituitary stalk is central. Four different locations for pituitary stalk with percentage incidence of anterior (13%), mid (40%) posterior (40%) and prominent tuberculum sellae (7%) were reported in literature in Turkish population [3]. In Chinese cadavers a percentage incidence of anterior (53.3% %), mid (40%) and posterior (6.7%) positions were reported [7].

Table 1: Age wise and sex wise distribution of Specimens

Prenatal Gestational age (wks) Groups	Prenatal cadavers Sex-Wise distribution		Postnatal Age (yrs) Groups	Postnatal cadavers Sex-Wise distribution		TOTAL Group and Sex-wise	
	F	M		F	M	F	M
(A) 11-15 wks	04	00	**(A) 11-20 yrs**	0 2	04	06	04
(B) 16-20 wks	12	09	(B)21- 30yrs	0 9	10	21	19
(C) 21-25 wks	14	10	(C) 31-40yrs	01	10	15	20
(D) 26-30 wks	13	14	(D) 41 – 50 yrs	01	10	14	24
(E) 31-35 wks	0 7	07	(E)51- 60 yrs	01	11	08	18
(F) 36-40 wks	0 5	05	(F) 61-70 yrs	01	04	06	09
TOTAL	**55**	**45**		**15**	**49**	**70**	**94**

Table 2: Position of pituitary stalk

Pituitary stalk position		Prenatal gland Number (%)	Postnatal gland Number (%)	TOTAL Sex-wise	TOTAL Percentage Position- wise
Anterior	**Females**	5 (9.1)	1 (6.6)	6 (8.6)	12 (7.0)
	Males	3 (6.6)	3 (6.1)	6 (6.4)	
Posterior	**Females**	14 (25.4)	7 (46.7)	21(30.0)	44 (27.0)
	Males	12 (26.7)	11 (22.5)	23(24.5)	
Middle	**Females**	36 (65.5)	7 (46.7)	43(61.5)	108 (66.0)
	Males	30 (66.7)	35 (71.4)	65(69.1)	
Total		**55**	**15**	**70**	**164**
		45	**49**	**94**	

Table 3: Number and percentage distribution of positions of chiasma

Chiasma	Prenatal cadavers Number (%)	Postnatal cadavers Number (%)	TOTAL Sex-wise	TOTAL
Females	03 (5.4)	02 (13.3)	05 (7.2)	09 (5.4)
Pre-fixed Males	03 (6.6)	01 (2.0)	04(4.2)	
Females	39 (71.0)	11 (73.4)	50 (71.4)	125 (76.3)
Normal Males	35(77.8)	40 (81.7)	75(79.8)	
Females	13(23.6)	02 (13.3)	15(21.4)	30 (18.3)
Post-fixed Males	07(15.6)	08(16.3)	15(16.0)	
Females	**55**	**15**	**70**	**164**
Total Males	**45**	**49**	**94**	

Table 4: Distribution of different shapes of diaphragm sella

Diaphragma sella shape		Prenatal Number (%)	Postnatal Number (%)	Total Sex-wise Number (%)	TOTAL Number (%)
Convex	Females	08 (14.5)	03 (20.0)	11 (15.7)	18 (11.0)
	Males	03 (6.7)	04 (8.0)	07 (7.4)	
Concave	Females	26 (47.3)	03 (20.0)	29 (41.3)	70 (42.7)
	Males	18 (40.0)	23(47.0)	41 (43.6)	
Flat	Females	21 (38.2)	09 (60.0)	30 (43.0)	76 (46.3)
	Males	24 (53.3)	22 (45.0)	46 (49.0)	
Total	Females	**55**	**15**	**70**	**164**
	Males	**45**	**49**	**94**	

Table 5: Distribution of different shapes of sellar opening

Sellar opening		Prenatal cadavers Number (%)	Postnatal cadavers Number (%)	Total Sex-wise %	TOTAL
Elliptical	Females	20 (36.4)	5 (33.3)	25 (35.7)	66 (40.0%)
	Males	21(46.7)	20 (40.8)	41(43.6)	
Round	Females	35 (63.6)	10 (66.7)	45(64.3)	98 (60.0%)
	Males	24 (53.3)	29(59.2)	53 (56.4)	
Total	Females	**55**	**15**	**70**	**164**
	Males	**45**	**49**	**94**	

Table 6: Gestational age wise distribution of fetal sella turcica and diaphragma sella parameters

S.No	Variable	11-15 wks	16-20 wks	21-25 wks	26-30 wks	31-35 wks	36-40 wks	Statistical significance
1	ST depth	0.20±0.00	0.32±0.62	0.43±0.08	0.51±0.07	0.59±0.05	0.54±0.05	F=48.79; p<0.001;**S**
2	ST length	0.25±0.06	0.41±0.07	0.46±0.06	0.52±0.07	0.51±0.06	0.49±0.06	F=16.67; p<0.001;**S**
3	SO A-P	0.13±0.05	0.23±0.08	0.25±0.07	0.27±0.09	0.33±0.10	0.31±0.05	F=6.27; P<0.001;**S**
4	SO trans	0.18±0.05	0.27±0.10	0.29±0.07	0.32±0.11	0.40±0.12	0.41±0.07	F=6.97; P<0.01;**S**

Table.7: Sex wise distribution of fetal sella turcica and diaphragma sella parameters in prenatal cadavers

Parameters	Male	Female	Statistical Significance
ST depth	0.48±0.10	0.43±0.13	F=4.62;p=0.03; **S**
ST length	0.48±0.08	0.46±0.09	F=0.63;p=0.43; NS
SO A-P	0.27±0.10	0.25±0.08	F=1.30;p=0.26; NS
SO trans	0.34±0.12	0.30±0.10	F=2.98;P=0.09;NS

In the present study, prominent tuberculum sellae was not observed and only three positions of stalk were observed as anterior (8%), mid (66%) and posterior (26%) in prenatal cadavers. In postnatal cadavers the percentage incidence was anterior (6%), mid (66%) and posterior (28%). The values obtained in the present study are differing from that reported in literature in Turkish and Chinese populations. During surgery for sellar pathology awareness of chiasmal and stalk locations helps in preventing damage to structures such as optic nerve, optic chiasma, 3rd and 4th cranial nerves, vascular structures and pituitary stalk [3].

Table 8: Age wise distribution of post-natal msella turcica and diaphragma sella parameters

S.No.	VariableS	11-20 yrs	21-30 yrs	31-40 yrs	41-50 yrs	51-60 yrs	61-70 yrs	Stat. Sig.
1	ST Length	0.92±0.10	0.91±0.11	0.94±0.19	0.97±0.13	1.03±0.22	1.04±0.13	F=1.45; p=0.22;NS
2	ST depth	0.90±0.06	0.88±0.14	0.94±0.07	0.95±0.05	0.95±0.08	1.00±0.00	F=2.13; P=0.08;NS
3	SO A-P	0.47±0.10	0.54±0.10	0.54±0.10	0.45±0.13	0.49±0.03	0.48±0.08	F=1.97; P=0.10;NS
4	SO trans	0.55±0.12	0.65±0.12	0.72±0.22	0.52±0.13	0.68±0.11	0.60±0.12	F=2.91; P=0.02;**S**

Table 9: Sex wise distribution of post-natal sella turcica and diaphragma sella parameters

S.No	Parameters	Male	Female	Statistical Significance
1	ST length	0.96±0.16	0.96±0.15	F=0.004;p=0.95;NS
2	ST depth	0.95±0.08	0.86±0.12	F=10.81;P=0.002;**S**
3	SO A-P	0.49±0.10	0.55±0.10	F=3.96;P=0.051;NS
4	SO trans	0.63±0.16	0.64±0.12	F=0.06;P=0.80; NS

The three positions of optic chiasma described in the literature were observed in the present study with a percentage incidence of pre-fixed (5.4%), post-fixed (18.3%) and normal (76.3%). The values obtained in the present study are nearer to the values reported in Turkish population [3]. The total percentage incidence of pre and post fixed types of optic chiasma are higher in females than that of males and the percentage of normal optic chiasma is less in females than in males in the present study. A detailed analysis of results of prenatal and postnatal cadavers presents interesting observations. In the prenatal cadavers except for the percentage incidence of post-fixed optic chiasma other two positions were higher in males. In the post-natal cadavers the percentage incidence of pre-fixed was higher in females, post-fixed was higher in males and the normal position was equal between sexes. This type of study sample and detailed analysis were not reported in the literature.

The appearance of upper surface of diaphragm sellae was reported flat in 43%, concave in 40% and convex in 10% of Turkish adult cadavers [3] and the results of present study are nearer to these values. In Chinese population 80% incidence of concave, 13.2% incidence of convex and 6.7% incidence of flat were reported in literature [7]. When analysed sex-wise it suggests a higher incidence of flat and concave shapes in males and a higher incidence of convex for females. When the data was compared between pre and post-natal groups except for higher incidence of convex shape in pre-natal females it showed higher values for males.

The size and shape of aperture in the centre of diaphragm sellae are variable. It is either round or elliptical in shape and is for the passage of stalk of pituitary gland. Its size is important in protecting the gland from transmitted pulsations of choroid plexus and for protecting the fibers of optic chiasma in cases of suprasellar extension of pituitary tumours. Variations in the morphometry of the sellar opening provides explanation for direction of growth of pituitary tumours towards cavernous sinus and supra sellar region [6]. The overall percentage incidence of round (60%) and elliptical (40%) shapes observed in the present study on Indian population of a wide age range could not be compared with the values reported in literature on adult Korean, Turkish British and Kenyan population [2-4,8].

The percentage incidence in pre-natal (round=58.5%; elliptical=41.5%) and post-natal (round=63%; elliptical =37%) age groups suggests a difference in percentage incidence of shape between pre natal and post natal age

groups. The percentage incidence among adult (> 20 yrs age) population of 58 cases among 64 post-natal are calculated the values suggests a 58.6% for round shape and 41.4% for elliptical shape. The percentage incidence of round and elliptical shapes (60%and 40%) reported in British and Korean adults are similar [4, 2]. In Turkish and Kenyan adults the percentage incidence of round and elliptical shapes (65%and 35%) are similar [3, 8]. The values obtained in the present study for Indian adults are differing from that reported in literature [2-4, 8].

When the result of present study are analysed sex-wise the incidence of round shape is higher when compared to elliptical shape in both sexes. In between the sexes the percentage incidence of round shape is higher in females in both pre (63%) and post-natal (67%) age groups when compared to males (53% and 59% respectively) in that age groups. The percentage incidence of elliptical shape is more in pre-natal males (47%) when compared to post-natal males (41%) and it is vice-versa for round shape. The sex differences in the shape of sellar opening observed in the present study were not reported in the literature.

The central opening of diaphragma sellae is classified in to closed and open types based on the longest diameter [2]. A longest diameter of more than 5mm is referred to as open type and one of less than 5 mm as closed type. In the literature a percentage incidence of 39-56% for more than 5mm i.e., Open type [4, 6, 9] in British and American, 78.8% in Korean [2] and 97.1% [8] in Kenyan adult cadavers were reported. Among 58 adult cadavers of more than 20 years age a percentage incidence of 96.5% was observed for a longest diameter of more than 5 mm in the present study suggesting a higher value for open type of diaphragm sellae opening in Indian population when compared to those reported in literature [2, 4, 6, 8, 9].This difference can be due to population variation.

The mean largest dimension reported on a total of 33 adult Korean cadavers (20 male and 10 female) was 6.8±1.7mm [2]. An average of 6.62±1.606 mm based on observations on 60 adult Turkish cadavers [3] was reported in literature. In Kenyan adult cadavers (96 males, 44 females) an average diameter of 8.97±2.24 mm was reported [8]. In the present study on 64 postnatal glands the mean largest dimension is 6.2±1.3. By excluding the 6 cases of less than 20 years group in postnatal cadavers the value is 6.3±1.4 in 58 adult cadavers (45 male and 13 female) suggesting a lower mean value for longest diameter in the present study when compared to the value reported in literature[2,3,8].

The sellar opening transverse diameter (SOTR) in prenatal age group is in the range of 0.1 to 0.6 cms and its antero-posterior diameter (SOAP) is 0.1 -0.55cm. In post-natal age SOTR is in the range of 0.4 to 1.2 cm and SOAR is in the range of 0.3 to 0.7 cm. The opening whether transverse or antero-posterior is in the range of 1mm to 6 mm in prenatal and 3 mm to 12 mm in postnatal groups. The range observed in the present study in post-natal cadavers is wider than that reported in Turkish population [3]. In Chinese population the average transverse diameter of 7.32mm (range, 3.10 ~ 13.40 mm) and the average antero-posterior diameter of 6.59 mm (range, 2.20 ~ 12.10 mm) were reported [7].

Between sellar opening transverse (SOTR) and sellar opening antero-posterior (SOAP) measurements in each of age-wise categories of pre and post natal groups presented higher values for SOTR in the present study in agreement with that reported in literature [8]. But the values of both SOTR and SOAP are statistically significant gestational age-wise in pre natal group and only SOTR in age-wise groups of post-natal specimens. Between sexes the values of SOTR and SOAP are not statistically significant. Significantly higher values were reported for females in the literature [8].

Sella turcica is an important region in skull base. Changes in size of it are frequently related to pathologies in pituitary gland. Its size varies with race and geographical location. The range of ST length is 2 to 6 mm. and ST depth is 2 to 7 mm in prenatal cadavers. The range of ST length is 8 to 14 mm. and ST depth is 6 to 11 mm in postnatal cadavers. According to Samira Zabhiyan et.al [10] the mean length is 9.16 mm±1.11 with a range of 6.5 to 12.5 mm and the mean depth is 8.56±1.25 mm with a range of 7.50 – 15.0 mm. The mean length in the present study in post-natal cadavers is 9.6±1.5 and the mean depth is 9.05±1.0 that are higher than that reported in literature. One way ANOVA carried out for various sella turcica parameters in pre and post-natal cadavers did not reveal statistically significant differences between different age groups but with reference to sex it revealed that only sella turcica depth is significant in different age groups whereas the other parameters are not significant in both pre and post-natal cadavers in the present study.

Conclusions

The present study on a large sample of (164) pituitary glands of wide age range of 12 weeks prenatal to 70 years postnatal and of both sexes is the first to be reported in literature. The findings of this study form an initial database for the Indian population which may provide sound anatomical knowledge during the transsphenoidal approach for the removal of pituitary tumour.

References

1. Amar AP, Weiss MH: Pituitary anatomy and physiology. Neurosurg Clin N Am 2003;14(1):11-23.
2. Ju KS, Bae HG, Park HK, Chang JC, Choi SK, Sim KM. Morphometric study of the Korean adult Pituitary glands and the Diaphragma sellae.J Korean Neurosurg Soc 2010;47:42-47.
3. Salih Gulsen, Ahmet Hakan Dinc, Melih Unal, Nergis Cantürk, Nur Altinors; Characterization of the anatomic Location of the Pituitary stalk and Its relationship to the Dorsum Sellae, Tuberculum Sellae and Chiasmatic Cistern, J Korean Neurosurg Soc 2010;47 :169-173
4. Rhoton AL. The sellar region. Neurosurg 2002; 51:S335- S374.
5. Kirgis HD, Locke W. Anatomy and embryology. In: Locke W, Schally AV, editors. The hypothalamus and pituitary in health and disease. Springfield, IL: Charles C. Thomas; 1972. p. 3–65.
6. Campero A, Martins C, Yasuda A, Rhoton AL. Microsurgical anatomy of Diaphragma sellae and its role in directing the pattern of growth of pituitary adenomas. Neurosurgery, 2008;62:717-723.
7. LIANG Jin, QI Song-tao, FAN Jun, SHI Jin, LU Yun-tao,YAN Xiao-rong. Anatomic features of diaphragma sellae and its clinic implications. Chinese Journal Of Clinical Anatomy 2013; 31(2):123-126.
8. Ongeti K, Hemed El-Busaid, Nelson Fundi. Reappraisal of the domensions of the diaphragm sellae. Anatomy Journal of Africa, 2012; 1(1):24-27.
9. Bergland RM, Ray BS, Torack RM. Anatomical variations in the pituitary gland and adjacent structures in 225 human autopsy cases. J Neurosurg 1968;28:93–9.
10. Samira Zabihyan, N. Dadgar, H. Etemadrezaie, A. Birjandi, R. Bahrami. Morphometry of Sella Turcica. Abstract- American Association of neurological surgeons, 2009 August. Article ID: 59229. https://www.aans.org/Media/Article.aspx?ArticleId=59229

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