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Original

Size and Morphology of Sella Turcica in Malay populations: A 3D CT Study

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Abstract: The purpose of this study was to analyse the linear and area dimensions and morphological shape of sella turcica to determine if differences exist due to gender or age and compared with available global data. A total of 183 (113 men and 70 women) Malay subjects who had their computed tomography (CT) scan at the Radiology Department, Hospital University Sains Malaysia (HUSM) for ordinary diagnosis not related to craniofacial deformities. The selected age groups were divided into four groups as children (0-6 years), pre-adolescents (7-12 years), adolescents (13-20 years) and adults (21-35 years). The images were processed using Mimics V17.0 software. Conventional measurements included three different heights of the sella turcica (anterior, posterior, median), its length, diameter, area and width, measured in relation to the Frankfort reference line (FH). Morphometric methods were used to assess shape. No significant differences in size of the sella were found except at sella height anterior between genders. When age was evaluated, significant differences were found among all age groups. The study found that sella turcica presented with a three different shapes: in a U shape (57.9 %), in a J shape (24.5 %) and shallow (17.5 %). Sella shape and dimensions reported in the current study can be used for discovering Pathological enlargement of the pituitary fossa and may also be helpful in providing reference data in the assessment of racial, gender and age specific variation in Malay population.

Key words: Morphometry, CT; Sella turcica; Malay

Introduction

Sella turcica is a saddle-shaped depression in the body of the sphenoid bone, an important anatomical structure for diagnosis of facial skeletal type and assessment of orthodontic treatments, because of its central reference point in the assessment of cranial morphology and intermaxillary relations. The sella turcica lies on the intracranial surface of the body of the sphenoid and consists of a central pituitary fossa bounded anteriorly by the tuberculum sellae and posteriorly by the dorsum sellae. Two anterior and two posterior clinoid processes project over the pituitary fossa[1,2].

The sella turcica forms a bony seat for the pituitary gland. Several pathologies of this gland can alter the shape and size of sella turcica. Some patients with an unusual sella turcica are suffering from several underlying diseases, intrasellar pituitary primary tumors, hypopituita-rism, or syndromes like Down syndrome, Williams or Sheehan's syndrome and Seckel syndrome[3,4]. The abnormal shape and size of the sella turcica provides insight to examine patients suffering from these conditions[5].

Clinicians should be conversant with the normal radiographic anatomy and morphologic variability of this area, even before these become clinically observable in order to distinguish and explore deviations that may reflect pathological situations in sella turcica[6,7].

Previous studies on linear and angular radiographic measurements of sella turcica had significant personal and ethnic differences[8]. Therefore, advance studies are required to obtain more data on this subject. It is essential to get information for the morphologic standard of people in all societies. The sella turcica size and morphology is different from person to person. Thus, obtaining any data in this regard will be a great help in detecting abnormalities in this anatomic area[9].

The cephalometric and CT radiographies are frequently evaluated by the dentists and orthodontists. By learning and

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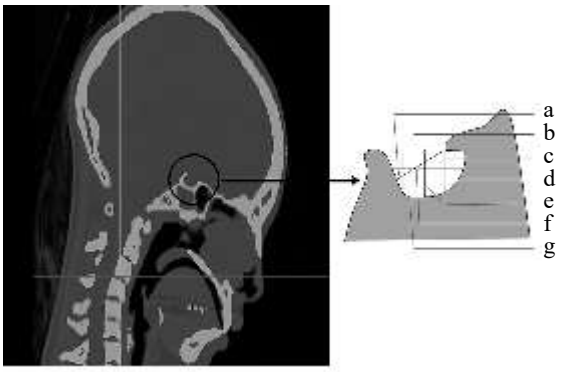

Figure 1. Saggital view shows Sella turcica parameters:
a., Sella diameter (TS-DS); b., Sella length (TS-Pclin); c., Sella height anterior (TS-SF); d., Sella height posterior (PClin-SF); e., Sella height median(SM-SF); f., Sella width (SA-SP); g., Sella area.

knowing the normal variations of the sella turcica, they will be able to distinguish abnormalities of this area[10].

Currently, research-ers in various fields of study such as radiology and orthodon-tics focus their attention for clarifying the morphology of the human craniofacial region[11]. The advanced development of imaging technology has made it possible to perform research that defines the morphology of the human body structures using radiographical images. CT and MRI are imaging modalities used to study and characterize the normal anatomy and the majority of pathologic processes in this region[12,13]. This have brought advantages to clinical and surgical activities, as well as to professionals involved in radiological interpretations. In this context, a deeper radiological study of the sella turcica has become necessary in order to better clarify certain issues involved in radiological study of this structure, which is importance in several medical specialties[14].

One must study the normal morphology of the sella turcica in order to determine whether the sella region presents with any unusual appearance. Morphology may vary from individual to individual, and the establishment of normal standards will aid in the process of eliminating any abnormality in such an important region. Therefore, the purposes of our study are as follows:

1. Determining sex related morphological shape and size of sella turcica in the Malay population.
2. Determining age related morphological shape and size of sella turcica in the Malay population.
3. Comparing the morphological size of sella turcica of the present study with global data.

Materials and Methods

Subjects

This randomised prospective descriptive study was con-ducted on 183 (113 men and 70 women) candidates who had their CT scan at the Radiology Department, HUSM. This study was approved by the Human Ethical Committee of the HUSM. Letter from Human Research Ethical Committee (HREC) has assigned a study protocol code USM/JEPeM/15060174. The selected age groups were divided into four groups as children (0-6 years), pre-adolescents (7-12 years), adolescents (13-20 years) and adults (21-35 years).

The selection criteria are as follows:

1. Subjects with CT images and the presence of the sella turcica with maximum clarity were selected.
2. All subjects were clinically healthy with no syndromes, clefts, or other craniofacial abnormalities either congenital, acquired through road traffic accidents or other forms of trauma and developmental discrepancies.
3. No significant pathology of the maxillofacial region.
4. No significant facial asymmetry.
5. No significant anatomical variation in the sella turcica and sphenoidal regions.
6. Patients using hormonal medications or corticosteroids were excluded from the study.

CT imaging

CT images were collected and saved in the Picture Archiving and Communication System (PACS) Server, Radiology Department, HUSM. These scans were of high resolution, helical scans obtained with General Electric (GE) Light Speed Plus CT Scanner System (GE company, Medical system group, Wisconsin, USA). The CT resolution was at 1.25 mm thickness and 1.25mm spacing. These scans could be accessed online.

3D Reconstruction

CT scans were saved in DICOM format, transferred to a personal computer, and reconstructed with a 3D image-segmentation program Mimics V17.0 software (Materialise N.V., Heverlee, Belgium). This software uses the existing axial view to create cross-sections in the sagittal and frontal views. The Hounsfield Unit (HU), which expresses the gray scale, was adjusted for each tissue in the CT system.

Measurements

Seven points were carefully selected and seven linear and area measurements were repeatedly made between identified point landmarks on each of the 3D image-segmentation using Mimics software program. Table 1 lists the landmarks used in this study and Fig. 1 shows the linear and area measurements using the above mentioned point landmarks. All linear and area measurements were repeated 3 times. The second measurements were conducted after 2 weeks, which the results were blinded to minimize the examiner's bias. For the third time, the same blinding was done which is 2 weeks after the second measurements. The averages of three readings of each measurement were considered for the statistical analysis in order to minimize the intra-examiner variation. A single

Table 1. Definition of landmarks.

Landmark	Name	Definition
TS	Tuberculum Sella	The most anterior point of the contour of the sella turcica
DS	Dorsum Sellae	The posterior wall of the sella turcica
SF	Sella Floor	The deepest point on the floor of pituitary fossa
PClin	Posterior Clinoid	The most anterior point of the PClin process
SA	Sella Anterior	The most anterior point of the sella
SP	Sella Posterior	The most posterior point of the sella
SM	Sella Medium	A point midway between PClin and TS
FH	Frankfort Plane	Is traced from Porion (Po): The most superior point on the upper rim of the external auditory meatus to Orbitale (Or): The most inferior point on the lower rim of the orbit

Table 2. Comparisons of sella turcica measurements between male and female subjects.

	Mean (SD) distance (mm)		95% Confidence Interval		
Variables	Male	Female	Lower Bound	Upper Bound	P value
TS-PClin	8.99(1.86)	9.19(1.80)	- 0.74	0.34	0.46
SA-SP	8.35(1.77)	8.33(1.56)	- 0.47	0.52	0.91
TS-DS	10.26(1.90)	10.54(1.90)	- 0.84	0.28	0.32
TS-SF	6.05(1.39)	6.60(1.42)	- 0.96	-0.13	<0.001***
PClin-SF	6.55(1.42)	6.54(1.23)	- 0.38	0.40	0.95
SM-SF	6.61(1.29)	6.66(1.19)	- 0.41	0.32	0.82
TS-SA-SF-SP- PClin	55.19(16.82)	56.75(17.34)	- 6.59	3.46	0.53

*p value < 0.05; **p value < 0.01 and ***p value < 0.001

Table 3. Descriptive statistics of sella turcica measurements of the study groups and the results of ANOVA test among all age groups.

Variable	Group 1 Mean(±SD)	Group 2 Mean(±SD)	Group 3 Mean(±SD)	Group 4 Mean(±SD)	p value
TS-PClin	9.01(±1.84)	8.05(±2.33)	9.41(±1.60)	9.11(±1.77)	0.03*
SA-SP	7.84(±2.16)	7.04(±1.33)	8.61(±1.55)	8.67(±1.48)	<0.001***
TS-DS	9.34(±2.20)	9.02(±1.91)	10.76(±1.66)	10.82(±1.66)	<0.001***
TS-SF	5.32(±1.54)	5.93(±1.47)	6.47(±1.35)	6.58(±1.29)	<0.001***
PClin-SF	5.24(±1.14)	6.19(±0.95)	6.69(±1.33)	7.01(±1.19)	<0.001***
SM-SF	5.57(±1.14)	6.25(±0.82)	6.66(±1.15)	7.09(±1.21)	<0.001***
TS-SA-SF-SP-PClin	46.08(±16.21)	48.07(±14.03)	59.04(±17.16)	59.00(±16.17)	<0.001***

*p value < 0.05; **p value < 0.01 and ***p value < 0.001

operator did all the measurements and the data were compared with those by other studies.

Statistical analyses

All data were analyzed using SPSS software 22.0 (IBM, Armonk, NY, USA). The normality of the data was evaluated with the skewness and kurtosis measurements. General descriptive statistics were calculated for each parameter. An independent t - test was used to calculate the mean differences in sella turcica linear and area dimensions between males and females. One way ANOVA was used to calculate the mean difference for all parameters among different age groups. Statistical significance was set at $p < 0.05$.

Results

Size of the sella turcica

Table 4. Linear and area sells turcica comparison among different study groups, results of ANOVA, Post Hoc test.

Variables	Groups		p value	95% Confidence Interval Lower	Upper
TS-PClin	Gr 1	Vs Gr 2	0.413	-.440	2.366
		Vs Gr 3	1.000	-1.526	.715
		Vs Gr 4	1.000	-1.183	.977
	Gr 2	Vs Gr 3	0.413	-2.366	.440
		Vs Gr 4	0.020*	-2.593	-.142
	Gr 3	Vs Gr 4	1.000	-.715	1.526
SA-SP	Gr 1	Vs Gr 2	0.540	-.450	2.045
		Vs Gr 3	0.234	-1.772	.219
		Vs Gr 4	0.131	-1.793	.128
	Gr 2	Vs Gr 3	0.540	-2.045	.450
		Vs Gr 4	0.001**	-2.663	-.484
	Gr 3	Vs Gr 4	0.234	-.219	1.772
TS-DS	Gr 1	Vs Gr 2	1.000	-1.064	1.701
		Vs Gr 3	0.004**	-2.524	-.316
		Vs Gr 4	0.002**	-2.542	-.412
	Gr 2	Vs Gr 3	1.000	-1.701	1.064
		Vs Gr 4	0.001**	-2.946	-.531
	Gr 3	Vs Gr 4	0.004**	.316	2.524
TS-SF	Gr 1	Vs Gr 2	0.745	-1.683	.448
		Vs Gr 3	0.002**	-2.008	-.305
		Vs Gr 4	<0.001***	-2.079	-.437
	Gr 2	Vs Gr 3	0.745	-.448	1.683
		Vs Gr 4	0.743	-1.470	.391
	Gr 3	Vs Gr 4	0.002**	.305	2.008
PClin-SF	Gr 1	Vs Gr 2	0.046*	-1.893	-.009
		Vs Gr 3	<0.001***	-2.202	-.698
		Vs Gr 4	<0.001***	-2.498	-1.048
	Gr 2	Vs Gr 3	0.046*	.009	1.893
		Vs Gr 4	0.641	-1.322	.322
	Gr 3	Vs Gr 4	<0.001***	.698	2.202
SM-SF	Gr 1	Vs Gr 2	0.274	-1.560	.218
		Vs Gr 3	<0.001***	-1.794	-.373
		Vs Gr 4	<0.001***	-2.203	-.833
	Gr 2	Vs Gr 3	0.274	-.218	1.560
		Vs Gr 4	0.948	-1.189	.364
	Gr 3	Vs Gr 4	<0.001***	.373	1.794
TS-SA-SF-SP- PClin	Gr 1	Vs Gr 2	1.000	-14.635	10.651
		Vs Gr 3	.005**	-23.057	-2.864
		Vs Gr 4	.003**	-22.655	-3.184
	Gr 2	Vs Gr 3	1.000	-10.651	14.635
		Vs Gr 4	.053	-22.010	.072
	Gr 3	Vs Gr 4	.005**	2.864	23.057

*p value < 0.05; **p value < 0.01 and ***p value < 0.001

Table 5. Global and present study data regarding sella turcica measurements.

Measurement	Unit	present study	Greece[4]	Saudi Arabia[19]	Pakistan [23]	Brazil [24]	Iran[25]	India[26]	Nigeria [27]	Turkey [28]
Instrument		a	b	b	b	a	b	b	c	b
No. subjects		183	184	180	180	100	90	180	100	118
Sella length	mm	8.46	7.1	11	11.4	10.31	9.04	8.8	12.59	×
Sella width	mm	8.21	8.9	×	×	×	×	×	×	11.1
Sella diameter	mm	10.79	×	13.9	13.9	×	13.02	10.9	×	14.1
Sella height anterior	mm	7.41	6.7	×	×	×	×	×	×	×
Sella height posterior	mm	7.40	6.6	×	×	×	×	×	×	×
Sella height median	mm	7.44	6.6	9.1	9.8	6.33	8.03	7.1	8.94	9.3
Sella area	mm	65.29	46.1	×	×	41.21	×	×	×	×

Instrument used for data collection: (a) CT; (b) Cephalometry; (c) lateral X-rays.

Table 6. Frequency distribution of sella turcica type.

Sella type	Frequency	Percentage
U shape	106	57.9
J shape	45	24.5
Flat	32	17.5

The linear and area dimensions of the sella turcica located in the mid saggital plane area are presented in Fig. 1. The average of three different heights of the sella turcica (anterior, posterior, median), its length, diameter and width, measured in relation to the FH. In addition, the area of sella turcica was calculated for both females and males are shown in Table 2. When comparing linear dimensions of sella turcica between genders, no significant differences between females or males in most parameters except for the Sella height anterior (TS-SF) could be found. On the other hand, when linear and area dimensions were compared with age, there were significant differences between the older and the younger age groups (Tables 3 and 4) for all linear and area dimensions. It was noted that sella turcica in the older groups was consistently larger than in the younger age groups. Furthermore, When our parameters were compared with those in other global data, disparities in all dimensions among different populations were observed (Table 5).

Shape of the sella turcica

In respect of its shape, the sella turcica was radiologically shown as three different shapes: in a U shape (57.9 %), when the dorsum and tubercle of the sella turcica are maintained at the same height; in a J shape (24.5 %), when the sella turcica tubercle is in a lower position in relation to the dorsum; and shallow (17.5 %), when the sella turcica depth is minimum as in Table 6.

Discussion

Further studies are expected to evaluate the effectiveness of radiographs for recognition of pituitary pathology. Cephalograms do not constitute the radiological technique for decision or conclusion of a suspected pituitary tumor. CT and magnetic resonance imaging provide much greater sensitivity[15]. On the other hand, coincidental discoveries noted by the orthodontist may prompt further examination of undiscovered or subclinical conditions[6,7,16].

Standardised information for the sella turcica as reference is currently available. However, they are basically limited to ordinary estimations, for example, height and length. Nowadays morphometrics analysis in the field of orthodontics was an encouraging force to apply objective methods for assessment of shape normality of the sella[17]. In addition to morphometric assessment, conventional linear and area measurements were incorporated. Large quantity of such data were found in the literatures but procedures of measurement vary mostly.

Following the concerns stated by Silverman (1957)[17], it was chosen to utilize the FH as the reference plane, so that vertical and antero-posterior measurements would be related to an external reference system and not be reliant on sella shape. This is a problem in studies where the antero-posterior diameter of sella is measured from TS to the most distant point on the opposite side of the outline since the direction of the measurement depends on the shape being measured and is not directly reliable between subjects[18].

The non-significant differences of sella turcica length, width, diameter and three different heights of the sella turcica (anterior, posterior, and median) between genders also recognised by Alkofide (2007)[19]. The sella turcica in males tends to be larger than that in females from about one year of age until about thirteen years. The pre-adolescent acceleration of growth in females began 2 years or earlier than males. In males, the acceleration occurs about 2 to 3 years later than in females, it is less noticeable, but

may persist longer[19].

Tetradis and Kantor (1999)[20] calculated the volume of the sella turcica using cephalometric radiographs. They found the volume in males to be larger than in females. Nevertheless their study was based on measuring only the volume of sella turcica and not sella turcica linear and area dimensions as in the present study[20].

Statistically significant correlations were found between age and several linear and area measurements in some cross-sectional studies. In another cross-sectional investigation, Tetradis and Kantor reported a tendency of increased size with age but this was not consistent between all successive age groups[21]. Rennert and Doerfler (2007)[11] measured volume in addition to width and height in a cross-sectional sample of orthodontic patients. They, too, found an increase in sella dimensions with age, from the 6 – 10 to the 21 – 25 age group. However, the change in height was minimal and probably not statistically significant (no SD values were given)[11]. Chilton et al. (1983)[22] reported on volume of the sella turcica and found an increase with age, as well as larger volumes in males than in females. It should be noted that an age-related increase of sella turcica size is expected because its contents, i.e. the hypophysis, have been shown to increase in size with age[22]. Therefore, longitudinal studies of sella size have provided positive results. Silverman reported that sella area increases steadily with age and follows the somatic growth pattern, possibly related to the function of the anterior lobe. Correlation of size to stature was higher than to age. Axelsson et al. (2004)[18] had also showed a stable increase in size for both genders during growth.

These findings of the linear and area dimensions and morphological shape of sella turcica were obtained from Malay population at Hospital Universiti Sains Malaysia. It is unknown whether similar findings might be obtained from other populations. Results of the few studies were shown in Table 5[4,19,23-28], however, it might be useful to carry out these linear and area dimensions and morphological shape of sella turcica in study populations from other institutions. The results of linear and area dimensions and morphological shape of sella turcica in a Pakistan[23], Iran[25] and Nigeria[27] populations shows larger values in comparison to present study. The following are the key results of this study: 1. No statistically significant differences in gender for all linear and area measurements except at sella height anterior. 2. There is statistically significant differences in sella size among all age groups for all linear and area dimensions. Sella sizes in the older age subjects were larger. 3. The results of the present study of sella shape and size may be used as reference standards for Malay subjects when studying sella turcica morphology. 4. Comparison the results of the present study with previous studies were showed disparities in all dimensions.

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Conflict of Interest

The authors have declared that no COI exist.

References

1. Jones RM, Faqir A, Millett DT, Moos KF and McHugh S. Bridging and dimensions of sella turcica in subjects treated by surgical-orthodontic means or orthodontics only. Angle Ortho 75: 714-718, 2005
2. Pisaneschi M and Kapoor G. Imaging the sella and parasellar region. Neuroimaging Clin N Am 15: 203-219, 2005
3. Elster AD. Imaging of the sella: anatomy and pathology. Semin Ultrasound CT MR 14: 182-194, 1993
4. Andredaki M, Koumantanou A, Dorotheou D and Halazonetis DJ. A cephalometric morphometric study of the sella turcica. Eur J Orthod 29: 449-456, 2007
5. Kjaer I, Hjalgrim H and Russell BG. Cranial and hand skeleton in frag-ile X syndrome. Am J Med Genet 100: 156-161, 2001
6. Feldkamp J, Santen R, Harms E, Aulich A, Mödder U and Scherbaum WA. Incidentally discovered pituitary lesions: high frequency of macroadenomas and hormone-secreting adenomas-results of a prospective study. Clin Endocrinol (Oxf) 51: 109-113, 1999
7. Alkofide E. Pituitary adenoma: a cephalometric finding. Am J Orthod Dentofacial Orthop 120: 559-562, 2001
8. Zagga AD, Ahmed H, Tadros AA and Saidu SA. Description of the nor-mal variants of the anatomical shapes of the sella turcica using plain radiographs: experience from Sokoto, Northwestern Nige-ria. Ann Afr Med 7: 77-81, 2008
9. Alkofide EA. Sella turcica morphology and dimensions in cleft subjects. Cleft Palate Craniofac J 45: 647–653, 2008
10. Choi WJ, Hwang EH and Lee SR. The study of shape and size of nor-mal sella turcica in cephalometric radiographs. Korean J Oral Maxillofac Radiol 31: 43-49, 2001
11. Rennert J and Doerfler A. Imaging of sellar and parasellar lesions. Clin Neurol Neurosurg 109: 111-124, 2007
12. FitzPatrick M, Tartaglino LM, Hollander MD, Zimmerman RA and Flanders AE. Imaging of sellar and parasellar pathology. Radiol Clin North Am 37: 101-121, 1999
13. Mazumdar A. Imaging of the pituitary and sella turcica. Expert Rev Anticancer Ther 6: 15-22, 2006
14. Kricheff II. The radiologic diagnosis of pituitary adenoma: an overview. Radiology 131: 263-265, 1979
15. Friedland B and Meazzini MC. Incidental finding of an enlarged sella turcica on a lateral cephalogram. Am J Ortho Dentofacial Orthop 110: 508-512, 1996

16. Halazonetis DJ. Morphometrics for cephalometric diagnosis. Am J Orthod Dentofacial Orthop 125: 571-581, 2004
17. Silverman FN. Roentgen standards for size of the pituitary fossa from infancy through adolescence. Am J Roentgenol Radium Ther Nucl Med 78: 45-60, 1957
18. Axelsson S, Storhaug K and Kjaer I. Post-natal size and morphology of the sella turcica-longitudinal cephalometric standards for Norwegians between 6 and 21 years of age. Eur J Orthod 26: 597-604, 2004
19. Alkofide EA. The shape and size of the sella turcica in skeletal Class I, Class II, and Class III Saudi subjects. Eur J Orthod 29: 457-463, 2007
20. Tetradis S and Kantor ML. Prevalence of skeletal and dental anomalies and normal variants seen in cephalometric and other radiographs of orthodontic patients. Am J Orthod Dentofacial Orthop 116: 572-577, 1999
21. Argyropoulou M, Perignon F, Brunelle F, Brauner R and Rappaport R. Height of normal pituitary gland as a function of age evaluated by magnetic resonance imaging in children. Pediatr Radiol 21: 247-249, 1991
22. Chilton LA , Dorst JP and Garn SM. The volume of the sella turcica in children: new standards. Am J Roentgenology 140:797 – 801, 1983
23. Shah AM, Bashir U and 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 Dent J 31: 104-110, 2011
24. Ruiz CR, Wafae N and Wafae GC. Sella turcica morphometry using computed tomography. Eur J Anat 12: 47-50, 2008
25. Valizadeh S, Shahbeig S, Mohseni S, Azimi F and Bakhshandeh H. Correlation of shape and size of sella turcica with the type of facial skeletal class in an iranian group. Iran J Radiol 12: 1-7, 2015
26. Sathyanarayana HP, Kailasam V and Chitharanjan AB. The size and morphology of sella turcica in different skeletal pattern among South Indian population. J Indian Orthod Soc 47: 266-271, 2013
27. Osunwoke EA, Mokwe CR and Amah-Tariah FS. Radiologic measurements of the sella turcica in an adult Nigerian population. Int J Clin Pharmacol Res 4: 115-117, 2014
28. Marşan G and Öztaş E. Incidence of bridging and dimensions of sella turcica in class I and III Turkish adult female patients. World J Orthod 10: 99-103, 2009