Original

3D CT Study of Morphological Shape and Size of Sella Turcica in Bangladeshi Population

Mushrath Islam¹, Mohammad Khursheed Alam², Asilah Yusof³, Ikuro Kato⁴, Yuma Honda⁵, Katsutoshi Kubo⁶ and Hatsuhiko Maeda⁷,⁸

¹ Orthodontic Unit, School of Dental Science, Universiti Sains Malaysia, Kelantan, Malaysia
² Orthodontic Department, College of Dentistry, Al Jouf University, Sakaka, Kingdom of Saudi Arabia
³ Craniofacial Morphology Unit, School of Dental Science, Universiti Sains Malaysia, Kelantan, Malaysia
⁴ Department of Oral Pathology, School of Dentistry, Aichi Gakuin University, Nagoya, Japan
⁵ Center of Advanced Oral Science, Aichi Gakuin University, Nagoya, Japan

(Accepted for publication, September 27, 2016)

Abstract: This study represents the morphology and measures the size and shape of the sella turcica in Bangladeshi populace and contrast with accessible global information. A sum of 166 (108men and 58 ladies) Bangladeshi subjects who went through Computed tomography (CT) scan at the Radiology Department were taken. A 3D imaging software (Mimics 11.02 Materialise) was utilized to process the CT images. Morphometric strategies were utilized to evaluate size and shape. The parameters for conventional measurements were three dissimilar sella height (anterior, posterior and median), sella length, diameter and width, where all of them deliberated in relation with Frankfort reference line (FH). Total area of sella turcica also considered. No important contrasts in size of the sella were found between sexes. The study found that sella turcica gave three unique shapes which were considered flat (28.3%), ovoid (48.1%) and circle (23.4%). In another morphological classification sella turcica represent 6 different variations. Those were normal sella (69.2%), oblique anterior wall (4.8%), double contour of sella floor (6.6%), sella turcica bridge (0 %), irregularity (notching) in the posterior part of the dorsum sella (16.2%) and pyramidal shape of dorsum sella (3.0%). Sella shape and measurements reported in the present study can be useful in giving reference information in the orthodontic determination, appraisal and treatment arrangement and evaluation of sex dimorphism in Bangladeshi subjects.

Key words: Morphometry, Sella turcica, Sella size, CT, Morphology

Introduction

Sella turcica is an essential anatomic structure in the midcranial region that houses the pituitary gland; it was named by comparative shape to Turkish saddle without precedent for Blancard’s Physical Dictionary (1693)¹. The despondency in saddle is distinguished as pituitary fossa or hypophyseal fossa. The pituitary organ is arranged in the hypophyseal fossa. It is restricted by hard constituents of the sella turcica, anteriorly by tuberculum sellae, posteriorly by dorsum sellae and inferiorly by the bony roof of sphenoid air sinus²,³. Two fronts and two back clinoid process venture over the pituitary fossa. The front clinoid process is framed by the medial and anterior prolongations of the lesser wing of the sphenoid bone, and the back clinoid process stand for terminations of the dorsum sellae⁴.

Standardizing information on the measure of the sella turcica have been accounted for already and commonly run from 4 to 12mm for the vertical and 5 to 16 mm for the antero-posterior dimension 4-6 Changes in size of the sella turcica are every now and again identified with pathology⁵,⁶. Any anomaly or pathology in the gland could show from a changed state of sella turcica, to an unsettling influence in the direction of emission of glandular hormones, prolactin, growth hormones, thyroid stimulating hormone, follicular stimulating hormone, and thus on⁷. Subjects with a strange sella turcica may really have an undetected hidden disease⁸.

Sella turcica has a noteworthy significance in the field of orthodontics. The anterior form of sella turcica is helpful in assuming patient growth and in surveying the craniofacial morphology⁹. Orthodontists ought to be acquainted with the morphologic varieties of sella turcica that will help in diagnosing any basic pathology connected with it¹⁰,¹¹. The anatomy of sella turcica has been portrayed as variable. Sella turcica was separated into three fragments, comprising of an anterior wall, a floor, and a posterior wall. Morphologically, there are three essential sorts - Oval, round, and flat of which the initial two sorts are more basic. In other literature six types of morphological variations of sella
turcica was found. Those are normal sella turcica; Oblique anterior wall, Double contour of sella floor, Sella turcica bridge, Irregularity (notching) in the posterior part of the dorsum sella and Pyramidal shape of dorsum sella.\(^13\).

Previously cephalometric procedure was broadly acknowledged as a standard device for orthodontic treatment getting ready for a very long while. In any case, it has demonstrated a few hindrances due to the geometric twisting and superimposition of structures on the radiographs. Now a day's three-dimensional (3D) imaging modalities, for example, CT and cone-beam computed tomography (CB-CT) have played an essential part in dentistry. Due to lower radiation dosages, less consumption of time these procedures become extremely famous for maxillofacial analysis and treatment arranging. Without including the superimposition of anatomical structure orthodontists can imagine 3D pictures of craniofacial structures\(^14-15\). With the advent of so many 3D imaging software 2D images can reconstruct in 3D. Thus help orthodontist to get more accurate measurements for craniofacial structures\(^16-18\).

So the immense change of imaging strategies has made it conceivable to perform research that characterizes the morphology of the human body structures. Morphology may shift from one topographical area to other contingent on the sort of skull. The foundation of typical norms in Bangladeshi populace will help during the time spent dispensing with any anomaly in such an essential piece of cranium. Along these lines, the aim of this study was to break down the prevalent morphological shape and size and measure the linear measurements of sella turcica to figure out whether any distinction exists because of sexual orientation in Bangladeshi populace and to contrast the morphological size of sella turcica of the present study with global data.

**Materials and Methods**

**Subjects**

This was outline as a retrospective study. The study populace included CT scans of 166 (108 males and 58 females) Bangladeshi subjects who went through the CT procedures at the radiology department of Medinova Medical Services LTD. Data were collected from the archive with the proper permission from the authority for research uses. All the research related work in this study was done in School of Dental Science, Hospital Universiti Sains Malaysia (HUSM). The study protocol has been submitted for approval by the Ethical Committee of the HUSM, which complies with the Declaration of Helsinki. All subjects chosen based on inclusion and exclusion criteria.

**Inclusion criterion**

1. Subjects with age ranged between 18 to 65 years old.
2. Subjects had no history of plastic or reconstructive surgery.
3. High quality CT volumetric data with the closeness of the sella turcica with utmost clarity.

**Exclusion criterion**

1. Subjects with a history of previous maxillofacial, orthognathic, plastic, reconstructive surgeries or trauma involving the craniofacial structures.
2. Subjects with cleft lip or palate and other craniofacial deformities.
3. Subjects with wounds, burns, or scar tissues in the craniofacial region.
4. Subjects with previous orthodontic or prosthodontic treatment.
5. CT scans with poor resolution.

**CT imaging and 3D reconstruction**

CT images were possessed from CT database archive from year 2015 to 2016 of Medinova Medical Services LTD. These were high resolution scans, helical scans obtained with General Electric (GE) Light Speed plus Discovery VCT 128 slice, CT Scanner System (GE Company, USA). Resolution of the CT was at 1.25 mm thickness and 1.25mm spacing. CT scans were spared in Digital Imaging and Communications in Medicine (DICOM) design then was exchanged to an individual PC. The main tool used in this study was a 3D imaging software (Mimics 11.02 Materialise, Leuven, Belgium) in which all collected data were constructed to make out the 3D reconstruction virtual images for utilizing the current pivotal perspective to make cross-section in the sagittal and frontal perspectives.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sella length</td>
<td>The distance between TS to PClin.</td>
</tr>
<tr>
<td>Sella width</td>
<td>Biggest antero-posterior measurement, as measured parallel to the FH plane, from front to back.</td>
</tr>
<tr>
<td>Sella height anterior</td>
<td>The vertical distance, as measured opposite to the FH plane, from TS to the sella floor.</td>
</tr>
<tr>
<td>Sella height posterior</td>
<td>The vertical distance, as measured opposite to the FH plane, from PClin to the sella floor.</td>
</tr>
<tr>
<td>Sella height median</td>
<td>The vertical distance, as measured perpendicular to the FH plane, from the sella floor to a point midway between PClin and TS.</td>
</tr>
<tr>
<td>Sella area</td>
<td>Total area from TS-SA-SF-SP- Pclin.</td>
</tr>
</tbody>
</table>
Mushrath Islam et al.: 3D CT study of Sella Turcica

Measurements

Several landmarks points of sella turcica were choose cautiously. Those points were Tuberculum sella (TS), dorsum sellae (DS), sella floor (SF), posterior clinoid (P Clin), sella anterior (SA), sella posterior (SP), sella median (SM) and Frankfort plan (FH). Then range estimations were over and over made between distinguished point landmarks on each of the 3D picture division utilizing Mimics programming software. Table 1 demonstrated the parameters characterized utilizing the aforementioned landmark points. A solitary operator did all the measurements. All measurements were rehashed 3 times. After the primary measurements were finished, the outcomes were blinded to the eyewitness before attempting the second measurements. The same blinding was done when the eyewitness measured for the third time. To minimize the analyst’s predisposition the blinding was done. The normal of three readings of every measurement was considered for the last factual examination in request to minimize the intra-analyst variety.

Statistical analyses

Statistical Package for the Social Sciences (SPSS) software 22.0 (IBM, Armonk, NY, USA) was used for the statistical analysis of the data. Descriptive statistics such as mean values, standard deviations were generated for every parameter. With the help of skewness and kurtosis measurements normality of the data was examined. Independent t-test was used to compare the mean differences in sella turcica measurements between males and females.

Results

Shape of the sella turcica

The study found that sella turcica gave three unique shapes

Table 2. Frequency of morphological shapes of sella in Bangladeshi subjects

<table>
<thead>
<tr>
<th>Sella type</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on new classification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal sella turcica</td>
<td>115</td>
<td>69.2</td>
</tr>
<tr>
<td>Oblique anterior wall</td>
<td>08</td>
<td>4.8</td>
</tr>
<tr>
<td>Sella turcica bridge</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Double contour of sella floor</td>
<td>11</td>
<td>6.6</td>
</tr>
<tr>
<td>Irregularity (notching)</td>
<td>27</td>
<td>16.2</td>
</tr>
<tr>
<td>Pyramidal shape of dorsum sella</td>
<td>05</td>
<td>3.0</td>
</tr>
<tr>
<td>Based on old classification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ovoid</td>
<td>80</td>
<td>48.1</td>
</tr>
<tr>
<td>Flat</td>
<td>47</td>
<td>28.3</td>
</tr>
<tr>
<td>Circle</td>
<td>39</td>
<td>23.4</td>
</tr>
</tbody>
</table>

Table 3. Comparisons of sella turcica measurements between male and female subjects.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>Mean</th>
<th>SD</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sella diameter</td>
<td>Male</td>
<td>9.902</td>
<td>1.514</td>
<td>-0.333</td>
<td>0.607</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>9.784</td>
<td>1.140</td>
<td>0.569</td>
<td></td>
</tr>
<tr>
<td>Sella length</td>
<td>Male</td>
<td>8.637</td>
<td>1.842</td>
<td>-0.125</td>
<td>0.130</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>8.219</td>
<td>1.320</td>
<td>0.961</td>
<td></td>
</tr>
<tr>
<td>Sella height anterior</td>
<td>Male</td>
<td>7.214</td>
<td>1.238</td>
<td>-0.139</td>
<td>0.212</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>6.974</td>
<td>1.049</td>
<td>0.621</td>
<td></td>
</tr>
<tr>
<td>Sella height posterior</td>
<td>Male</td>
<td>6.937</td>
<td>1.216</td>
<td>-0.149</td>
<td>0.252</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>6.729</td>
<td>0.859</td>
<td>0.565</td>
<td></td>
</tr>
<tr>
<td>Sella height median</td>
<td>Male</td>
<td>6.614</td>
<td>1.174</td>
<td>-0.214</td>
<td>0.458</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>6.485</td>
<td>0.805</td>
<td>0.472</td>
<td></td>
</tr>
<tr>
<td>Sella width</td>
<td>Male</td>
<td>8.426</td>
<td>1.305</td>
<td>-0.630</td>
<td>0.308</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>8.641</td>
<td>1.247</td>
<td>0.200</td>
<td></td>
</tr>
<tr>
<td>Sella area</td>
<td>Male</td>
<td>54.934</td>
<td>13.081</td>
<td>-5.100</td>
<td>0.637</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>55.919</td>
<td>12.086</td>
<td>3.130</td>
<td></td>
</tr>
</tbody>
</table>
which were considered as older shapes, where ovoid was most frequent about (48.19%), then flat (28.3%) after that circle (23.4%). In another morphological arrangement sella turcica speak to 6 unique varieties which were considered as more current shapes. Form of sella turcica was observed to be normal in dominant part of subjects (69.2%). Oblique anterior wall was found in 4.8%; double contour of sella floor was found in 6.6% of the subjects; irregularity of posterior wall was found in 16.2%; pyramidal shape of dorsum sellae stood for 3.0 % while no sella turcica bridge was found in total subjects (Table 2).

Size of the sella turcica

The direct estimation of sella turcica in the mid sagital plane in both sexual orientations is exhibited in Table 3. The average of three distinct statures of the sella turcica (anterior, posterior, middle), its length, distance across and width, deliberated in connection to the FH. Likewise, the territory of sella turcica was also ascertained for both females and males are appeared in Table 3.

The mean length of sella turcica in males and females fluctuated by just 0.04 mm being 8.637 mm in males and 8.219 mm in females. So also correlation of the mean width between both sexual orientations the mean worth shifted by as it were 0.02 mm being 8.641 mm in females and 8.426 mm in males. On correlation of mean diameter between the male and female the qualities were differ only 0.01 mm i.e. 9.902 mm in males and 9.784 mm in females. In addition, the area of sella turcica was calculated for both sexes 55.919 mm for females and 54.934 mm for males. On examination of the p esteem in each of the three direct measurements between sexes no noteworthy distinction was found regarding length, depth and distance across (Table 3). Besides, at the point when our parameters were contrasted and those in other worldwide information19-21), inconsistencies in all measurements among various populaces were watched (Fig. 1).

Discussion

This retrospective study portrays the shape and size of the sella turcica i.e. the morphological shape, linear measurement and territory of sella turcica in Bangladeshi populace. The morphological varieties in sella turcica has been accounted by numerous analysts through time5-23).

In the year 1922 Gorden and Bell analyzed radiographs of normal children in the middle of 1 and 12 years old and arranged sella turcica into three shapes, ovoid, circle, flat/saucer formed. Circle or ovoid formed sella turcica were seen in greater part of subjects, and they touched base at a conclusion that not all cases could effectively be put into such a wide three-way classification23).

Axelsson et al. 22) led a study in Norway utilizing parallel cephalometric radiographs of males and females in age range of 6-21 year in 2004 to decide varieties in shape and size of sella turcica. The sella turcica morphology was dissected and six sorts of various morphological variations like normal sella turcica, oblique anterior wall, bridging of sella turcica, double contour of sella floor, irregular surface (notch like depression) in the posterior aspect of the dorsum sellae, pyramid-like shape of the dorsum sellae were perceived. Their outcome demonstrated that the normal variety of sella turcica was found in two/third of the subjects while the remaining subjects indicated dysmorphological appearance. The variety of the sella turcica morphology aside from normal can delude since it might be present in normal patients and
additionally medically compromised patients such as spina bifida or craniofacial deviation\cite{20}.

In 2008, Alkofide led a study to assess the morphological states of sella turcica in cleft lip and palate patients. As per study he met up at result dominant part of separated subjects had morphological deviations, for example, double contour of the floor, an irregular posterior wall discovered more usually than the normally formed sella turcica. As opposed to people with clefts, in most of non-cleft subjects the morphology of the sella turcica has all the feature of being normal\cite{29}.

Previously in a comparative study utilizing the same 6 primary sorts of sella shapes as Axelsson et al. had utilized also, reported that comparable discoveries that nearly in 67\% (two/third) of the subjects occupied by the normal variety of sella shape\cite{8,22}.

In current study the normal variety of sella turcica was seen in 69 % of the subjects while 31% with various variety. These qualities are identical in both studies. The finding of the irregularity in the notching of the dorsum sella was more noteworthy in the present study being 16.2\% while earlier in that study it was 11\%. The distinction in the values between the two studies can be credited to the ethnic contrast between the two examples as that study utilized Norwegian populace though our study included a Bangladeshi populace. The rate of recurrence of double contour was verging on comparative in both current and the previous study.

In that earlier study, sella turcica bridging in normal person is not unprecedented and identified in 5.5-22\% of the populace\cite{8}, however there is expansion in event in patients with craniofacial deviation.

In current study however the expansion was found in none of the subjects. Thus stands for being much lower than previously issued. It makes an intriguing point for future researchers with respect to whether the sella turcica bridge even exists in normal subjects in our populace. The present study demonstrated just 4.8 % of subjects with an oblique anterior wall contrasted with 26\% seen by Axelsson et al in 2004.

Like the morphological studies various investigations have been done on the size of sella turcica, though the techniques vary generally\cite{12,19-23,20}. No noteworthy sexual orientation contrasts were found in deciding the contrasts amongst males and females as far as sella turcica size in the current study.

Comparative discoveries were accounted for by Israel (1970)\cite{51} who inferring that the sella turcica size in young adult males and females were just about the same, despite the fact that he noticed that the sella turcica size may increment in males with age.

In a study by Alkofide (2007)\cite{8}, radiographs of 320 subjects, running in age from 1 month to 18 years, mean sella territory was deliberated (length and depth). The discoveries presumed that pituitary fossa of males had a tendency to be bigger than the females around 1 to 13 years old.

As a result of the pubertal development spurt which happens 2 years sooner than guys, a noteworthy increment in size of the sella turcica happen from 11 to 15 years of age\cite{8}. Thereafter the pubertal development spurt in males happens around 2-3 years after the fact than females coming about in around evening out in sella region in both sexual orientations.

Current studies outcome is connecting with studies done by Yassir et al. 2010 in Iraq populace, Shah et al. 2011 in Pakistan populace, Chavan et al. 2012 in Maharashtra populace, Osunwoke et al. 2014 in Nigerian populace, where between sexual orientations no noteworthy contrast was found as far as length, depth and diameter\cite{11,13-14}. Taking into account the consequences of this study, sexual orientation contrasts were measurably unimportant for all linear and area estimations of sella turcica. The sella shape and size might be utilized as reference measures for Bangladeshi subjects when examining sella turcica morphology.

### Acknowledgment

This study was supported by USM RUI Grant 1001/PPSG/812154.

### Conflict of Interest

The authors have declared that no COI exist.

### References

10. Bishara SE and Athanasiou AE. Cephalometric methods for


