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Radiological evaluation of sella turcica dimensions in patients with empty sella

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Abstract

Empty Sella (ES) occurs when the subarachnoid space is herniated into the Sella Turcica (ST). ES may be radiologically determined randomly, and patients with ES are usually asymptomatic. However, approximately 20% of partial ES (PES) cases can be symptomatic. Therefore, it is essential to diagnose patients with ES accurately for treatment. We studied whether there was a difference in ST dimensions between patients with ES and healthy individuals using magnetic resonance imaging (MRI), and we compared a group of measurements using computed tomography (CT). 212 patients with ES and 98 healthy individuals participated in this study and underwent cranial 3T MRI. We divided the study population into three groups: the PES, total ES (TES), and control groups. We placed the patients who underwent both cranial MRI and paranasal CT in a separate group. The aperture, height, and length of the ST of all subjects were measured. MRI and CT showed that the length, height, and aperture diameters of the ST were statistically significantly different between the PES, TES, and control groups ($p<0.05$). In receiver operating characteristic analysis, the cut-off values for the length, height, and aperture measurements were 12.05 mm, 8.35 mm, and 9.65 mm, respectively. The dimensions of the ST expand in patients with ES, and we found a reliable threshold value for this expansion. CT taken for unrelated reasons may be used in the diagnosis of ES by measuring the dimensions of the ST.

Keywords: radiological evaluation, sella turcica, dimensions, empty sella

1. Introduction

Empty Sella (ES) occurs when the subarachnoid space is herniated into the Sella Turcica (ST), causing the pituitary gland to flatten in various degrees (1–3). ES has primary or secondary causes (4). Primary ES is less common than secondary ES (5, 6). The etiology of primary ES is unknown (3, 4). However, researchers have explained several causative mechanisms, including incompetence or complete absence of the diaphragma sellae, chronic intracranial hypertension (pseudotumor cerebri, brain tumors, intracranial thrombosis, and hydrocephalus), and temporary expansion followed by regression of the pituitary gland (e.g., expected increase in pituitary volume during pregnancy and lactation and spontaneous regression in pituitary volume during menopause) (5,6). Trans-sphenoid treatments, infections, bleeding, infarction, trauma, and pituitary autoimmune diseases cause secondary ES (3,4).

Primary ES may be radiologically determined randomly and patients with primary ES are usually asymptomatic (3,7). However, in approximately 20% of primary ES cases, endocrine, neurological, ophthalmological, and psychiatric symptoms may occur (7). Headache, menstrual irregularities, galactorrhea, hirsutism, and sterility are the most common clinical findings in patients with primary ES (7). In particular, headache and obesity are considered the most common clinical symptoms in men and women, respectively (3, 4). Therefore, it is crucial to diagnose patients with ES accurately for treatment.

ES is diagnosed using magnetic resonance imaging (MRI) of the sellar and suprasellar regions. Computed tomography (CT) can be used in patients with MRI contraindications. In CT and MRI, typical findings of ES (8) are intrasellar CSF filling in continuity with overlying subarachnoid spaces, residual pituitary gland with a semi-lunate shape flattened against the sellar floor, and enlarged bony sella (1–4, 6–8). CT and encephalograms have low sensitivity in diagnosing ES due to their low soft-tissue resolution. However, MRI is highly sensitive.

This study determined whether there was a quantitative difference in ST measurements between patients with ES and healthy individuals.

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2. Materials and Methods

2.1. Patient Population

212 patients with ES and 98 healthy individuals who met the study criteria participated in this retrospective study between January 2018 and June 2020 and underwent cranial MRI and paranasal CT. Ethics committee of Faculty of Medicine of Muğla Sıtkı Koçman University approved this study. We included patients aged over 18 and under 70 with nonspecific symptoms such as headache and dizziness who underwent MRI. We excluded patients with any anatomic malformation, trauma, history of surgery, and non-diagnostic MR images. We conducted this study the World Medical Association's Declaration of Helsinki principles.

2.2. MR and MDCT Imaging Protocol

We obtained MR images using a 3T scanner (MAGNETOM Skyra; Siemens Healthineers, Berlin, Germany) and performed ST measurements on sagittal T2-weighted brain MR images. We obtained images using a protocol of 384×278 matrix, a field of view (FOV) of 23.5 cm, repetition time of 3360 milliseconds (TR 3360 msec), echo time of 75 milliseconds (TE 75 msec), number of excitations of 1 (NEX), and slice thickness of 3.5 mm.

We obtained the paranasal CT images using the following protocol: FOV, 180 mm; slice thickness, 3 mm; kvp, 120; and mAs, 150. After the images were obtained, multiplanar reconstructions were performed and measurements were made from reconstructed images. We took sagittal images of the ST and performed, the length, height, and aperture measurements of the ST on the sagittal images.

2.3. Image Analysis

A radiologist with ten years of experience, blinded to the subjects, evaluated the ST length, height, aperture and shape. We divided the study population into three groups: the partial empty sella (PES), total empty sella (TES), and control groups. On MRI, PES is defined as less than 50% of the sella filled with cerebrospinal fluid (CSF) and pituitary size of 3 mm, and TES is defined as more than 50% of the sella filled with CSF and pituitary size of 2 mm (7, 9–11). Furthermore, we grouped participants according to gender.

We placed thirty-five patients who underwent both cranial MRI and paranasal CT in a separate group. We compared ST measurements based on compliance in patients who underwent MRI and multidetector CT examination.

We named the distance between the dorsum sellae and tuberculum sellae ends as the aperture, the height was the line extending from the deepest point of the sellar base to the aperture, the length was the distance between the top of the tuberculum sellae and the deepest point of the posterior wall of the dorsum sellae. We measured these parameters (Fig. 1), and classified the shape of the ST on the sagittal images as type 1, round; type 2, oval; and type 3, flattened (Fig. 2).

2.4. Statistical Analysis

We performed the statistical analyses of the data using Statistical Package for the Social Sciences, version 20.0 (IBM Corp., Armonk, NY, USA) and evaluated the conformity of the data to a normal distribution using the one-sample Kolmogorov–Smirnov test. We performed the paired sample t-test to compare the measurement compliance of the patients who underwent MRI and multidetector CT and recorded the patient's demographic data. We presented the ST's length, height, aperture as mean ± standard deviation (SD) and conducted and independent-samples t-test to evaluate statistical differences between men and women and One-way ANOVA to detect differences between the patient and control groups. We compared the groups using the Tukey test and calculated cut-off values using receiver operator characteristics (ROC) curve analysis between the patient and control groups. We presented the ST shape as a percentage (%) and used P values of 0.05 to denote statistical significance.

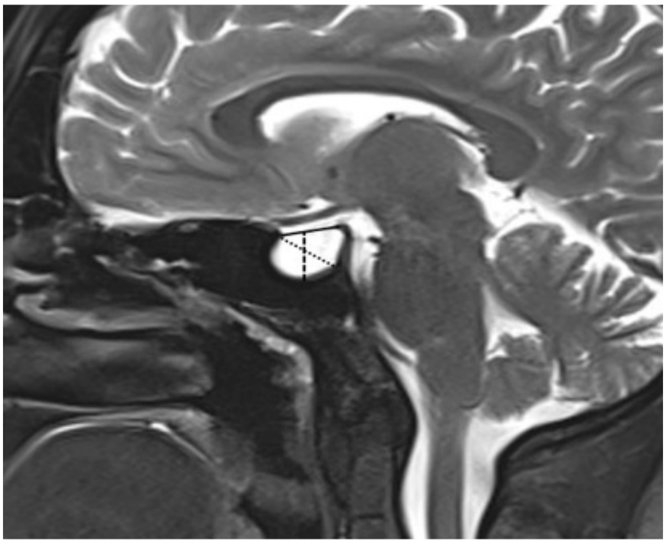

Fig. 1. On sagittal MR images, the length, height and apertura of sella turcica

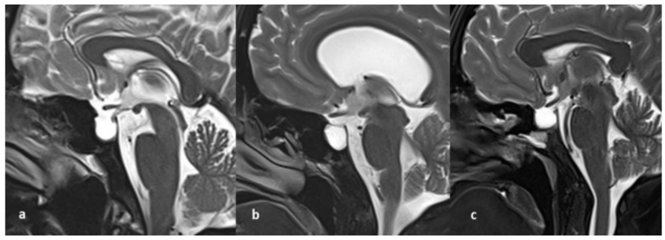

Fig. 2. The shape of the sella turcica on the sagittal MR images. (a) round, (b) oval, (c) flattened

3. Results

The total study population comprised 59 men and 153 women with a mean age of 54.21 ± 12.60 years (18–69 years). The MRI and multidetector CT examination perfectly agreed with the ST measurements ($p>0.05$). Table1 shows the length and height values of the ST according to gender. The aperture was higher in men than in women ($p<0.034$).

Table 2 shows the ST's length, height, and aperture values according to the groups. The ST's length, height, and aperture were significantly different between the PES, TES, and control groups (Table 2). Table 3 shows the percentage distribution of the ST shape.

Table 1. The mean dimensions of Sella Turcica in patients with empty sella by gender

	Female (n=153) Mean±SD	Male (n=59) Mean±SD	p
Length (mm)	13.46±2.63	12.94±2.23	0.102
Depth (mm)	9.40±2.08	8.83±1.78	0.297
Apertura	10.52±1.96	10.60±1.94	0.034

Table 2. The mean dimensions of Sella Turcica in empty sella patients and control groups

	Partial ES Mean±SD	Total ES Mean±SD	Control Mean±SD
Length (mm)	14.10±1.60[a,b]	15.03±2.81[a]	10.83±0.96
Depth (mm)	9.73±1.56[a, c]	10.34±2.39[a]	7.66±1.03
Apertura	11.06±1.36[a,d]	11.73±2.35[a]	8.88±0.93

Data are n of participants, mean±SD.
a P<.001 compared with control group (One way ANOVA-Tukey test).
b P<.001 compared with TES group (One way ANOVA-Tukey test).
c P<.05 compared with TES group (One way ANOVA-Tukey test).
d P<.01 compared with TES group (One way ANOVA-Tukey test).

Table 3. The shapes of Sella Turcica in patients with empty sella

	PES (n=132)	TES (n=80)	Control (n=98)
Round	70 (53.03%)	34 (42.50%)	49 (%50%)
Oval	20 (15.15%)	25 (31.25%)	23 (23.47%)
Flattened	42 (31.82%)	21 (26.25%)	26 (26.53%)

We calculated cut-off values in ROC analysis for the length, height, and aperture measurements (Table 4).

Table 4. Sensitivity and specificity values in patients with empty sella according to ROC analysis

	Cut-off values	Sensitivity (%)	Specificity (%)	p
Length	12.05	92.9	91.8	0.001
Depth	8.35	81.1	81.6	0.001
Apertura	9.65	87.3	81.6	0.001

4. Discussion

This study, evaluated changes in the ST sizes in patients with PES and TES compared with the healthy control group. This study bore some significant findings. First, the sizes of the ST in the TES group were significantly larger than the PES and control groups. Second, the sizes of the ST in the PES group were significantly larger than in the control group. Third, the values of 12.05 mm, 8.35 mm, and 9.65 mm for the ST's length, height, and aperture respectively, are reliable thresholds to distinguish ES.

The size of the ST varies in different populations. The dimensions were smaller in the control group of this study than those in the Saudi and Caucasian populations but similar to those in the Norwegian, Iraqi, and Greek populations (12–17). The aperture values of the ST were higher in men with ES than those in women in our study ($p<0.034$), and we found no significant difference in other measurements. However, other studies reported no statistically significant differences between men and women regarding the ST's length, height, and aperture in their normal population (12–19).

If there are no contraindications, diagnosing ES is achieved using MRI (3). However, the literature measured ST bone sizes using direct radiography and CT (12–19). We performed the measurements in this study using MRI. We found that the patients who underwent both MRI and CT had high conformity by comparing MRI and CT measurements. We found in the literature no study investigating this type of correlation. Although CT is preferred in evaluating bone structures, our measurements using MR images indicate that the dimensions of the sella can be measured using MRI similar to CT.

Enlargement of the ST has been reported in patients with ES (1–8). This has been associated with the formation mechanisms. Incompetent diaphragma sellae and intracranial hypertension allow the accumulation of CSF into the ST, causing its enlargement. Initially, the pituitary gland enlarges, followed by a later decrease in gland size, which creates a space in which CSF can accumulate. Examples include an expected increase in pituitary volume during pregnancy and lactation and then spontaneous regression during menopause (5, 6, 20, 21). However, the threshold of this expansion has not been reported. We calculated the threshold value that would suggest the presence of enlarged sellae in patients who applied at our clinic. The values of 12.05 mm, 8.35 mm, and 9.65 mm for the sellar length, height, and aperture, respectively, are reliable thresholds to distinguish ES. As such, MRI and clinical evaluation could help diagnose ES in patients with increased sellar sizes who underwent CT and X-ray examinations involving the sellar region for any reason.

The shape of the ST can be round, oval, or flat. The most common types are round and oval (18,22). These classifications are based on the contours of the sellar floor and the angles formed by the contours of the anterior and posterior clinoid processes and the tuberculum sellae (23, 24). We used in this study, the basic shapes (oval, round, and flattened) to classify the ST and found round to be the most frequent shape in all groups (the control, PES, and TES groups). Although the size of the ST increased in patients with ES, it seemed that there was no change in shape. Many studies have investigated the shape of the ST in normal populations; however, we could not find any recent research examining the shape of the ST in patients with ES.

This study has some limitations. First, patient randomization may be impaired due to the study' retrospective nature. Second, a single radiologist made the measurements. Third, the results revealed the values of the patients evaluated in our hospital. However, the results, especially the threshold value findings, should be compared with multi-center studies or studies from different regions.

In conclusion, we have determined that the dimensions of the ST expand in patients with ES and found a reliable threshold value for this expansion. We believe that the maxillofacial and cranial CT taken for unrelated reasons can be used to diagnose ES by measuring the dimensions of the ST and can be used to refer the patient for further clinical evaluation.

Conflict of interest
None to declare.

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Authors' contributions
Concept: R.M.K., Design: R.M.K., Ö.Y., Data Collection or Processing: Ö.Y., M.Y.Ö., Analysis or Interpretation: Ö.Y., M.Y.Ö., Literature Search: R.M.K., N.Ç., Writing: R.M.K., N.Ç.

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