**Cukurova Medical Journal**
ÇUKUROVA ÜNİVERSİTESİ TIP FAKÜLTESİ

Cukurova Med J 2020;45(2):738-745
DOI: 10.17826/cumj.694981

**ARAŞTIRMA / RESEARCH**

# Determination of sella turcica types in healthy Turkish population

## Sağlıklı Türk popülasyonunda sella turcica tiplerinin belirlenmesi

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*Cukurova Medical Journal 2020;45(2):738-745*

**Abstract**

**Purpose:** The aim of this study was to determine the age and gender differences of sella turcica types in healthy Turkish individuals using lateral cephalometric radiographs and make an analysis of sella turcica types.
**Material and Methods:** A total of 222 patients of which 93 females and 129 males in the age group of 1-46 years who applying to the Department of Radiology with various reasons were included in our study and the classification of sella turcica types was assessed. Measurements were classified both in terms of gender, and age groups. Sella turcica types were analysed according to the two classification methods performed by Meyer Marcotti et al., and Axelsson et al.
**Results:** Significant differences were found between gender and sella turcica types according to Axelsson et al's classification method. Furthermore, the sella turcica bridging type in males and variation combination type in females were no found. On the other hand, there were no considerable differences between sella turcica types and age groups according to Axelsson et al's classification; whereas, the significant difference was found between age groups and sella turcica types according to Meyer Marcotti et al's classification.
**Conclusion:** The data obtained in our study will shed light on monitorize of growth of individual by enabling determination of the sella turcica types in various diseases and different age groups, and the knowledge of the anatomic variations for sella turcica typology of Turkish population.
**Keywords:** Sella turcica classification, sella turcica shapes/types, variation

**Öz**

**Amaç:** Bu çalışmada, sağlıklı Türk populasyonunda sella turcica tiplerinin yaş ve cinsiyete göre farklılıklarını lateral kafa grafileri kullanılarak belirlemek ve sella turcica tiplerinin analizinin yapılması amaçlanmıştır.
**Gereç ve Yöntem:** Yaşları 1-46 yıl arasında değişen, çeşitli nedenlerle Radyoloji Bölümü'ne başvuran 93 kadın ve 129 erkek toplam 222 kişi çalışmaya dahil edildi ve sella turcica sınıflandırılması yapıldı. Ölçümler cinsiyet ve yaş grupları açısından değerlendirildi. Sella turcica tipleri Meyer Marcotti ve arkadaşları ile Axelsson ve arkadaşları tarafından yapılan iki sınıflandırmaya göre analiz edildi.
**Bulgular:** Axelsson ve arkadaşlarının sınıflandırma metoduna göre cinsiyetler arasında anlamlı farklılık bulundu. Ayrıca, erkeklerde sella turcica köprüleşme tipine, kadınlarda varyasyonların kombinasyonu tipine rastlanılmadı. Diğer taraftan, Meyer Marcotti ve arkadaşlarının yapmış oldukları sınıflandırmaya göre yaş grupları ile sella turcica tipleri arasında anlamlı farklılık bulunmasına rağmen, Axelsson ve arkadaşlarının yapmış oldukları sınıflandırmaya göre sella turcica tipleri ve yaş grupları arasında anlamlı farklılık bulunmadı.
**Sonuç:** Çalışmamızda elde edilen bulgular çeşitli hastalıklarda ve farklı yaş gruplarında sella turcica tiplerinin belirlenmesine ve Türk populasyonunun sella turcica tipolojisi için anatomik varyasyonların bilgisine olanak sağlayarak bireyin gelişiminin izlenmesine ışık tutacaktır.

**Anahtar kelimeler**: Sella turcica sınıflandırması, sella turcica tipleri, varyasyon

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Geliş tarihi/Received: 26.02.2020 Kabul tarihi/Accepted: 30.04.2020 Çevrimiçi yayın/Published online: 23.05.2020

## INTRODUCTION

The sella turcica is a very crucial structure in the radiographic analysis of the neurocranial and the craniofacial regions, and also, when assessment of growth changes, orthodontic treatment results, diagnosis of facial skeletal types[1-5]. The sella turcica named as Turkish saddle is located in the middle cranial fossa on the upper surface of the sphenoidal bone body. It is bordered by the anterior and posterior clinoid processes. The sella turcica is formed of three parts known as tuberculum sellae (saddle horn), hypophysial fossa (pituitary fossa) covered by diaphragma sellae, and dorsum sellae (back of the saddle)[1,2,6-11].

In embryological development of the sella turcica is a key point for the migration of the neural crest cells to the frontonasal and maxillary developmental fields[1,2,6,7]. The greater part of the sphenoid bone develops using the endochondral method of ossification. Until the seventh or eight month of foetal life, the body of the sphenoid consists of two parts named the presphenoid (in front of the tuberculum sellae) and the postsphenoid (consisted the sellae turcica and dorsum sellae). While the anterior part of the sellae turcica in the early embryonic period develops mostly from neural crest cells, the posterior part of the sella turcica develops from parachordal mesoderm in direct relation to the notochord[2,7]. It has been stated that the structural deviations in the anterior wall may be related to specific deviations in the facial skeleton[7]. Additionally, the sella turcica is the most important orthodontic central landmarks in the evaluation of the cranial morphology and intermaxillary relations[5,9].

The neural crest cells and mesodermal cells are of significance in embryologic development. Therefore, some variations in the development of sella turcica may be seen. Also, the shape anomalies originate from both functional disorder in the pituitary gland and morphological posterior border by the dorsum sellae[12]. Sella turcica development is closely related with pituitary gland development. The pituitary gland development finishes before the sella turcica completely develops. So, there was a connection between the sella turcica deviations and abnormality of the pituitary gland and brain[7,12]. Since the sella turcica contains the pituitary gland, the shape and size of the sella turcica will change in pituitary gland pathologies. Furthermore, an abnormality in sella turcica may happen for some reasons such as intrasellar pituitary primary tumors, hypopituitarism, spina bifida, Trisomy 18-21, Williams syndrome and Down syndrome. However, the morphology of the sella turcica may vary between individuals and according to ethnicity[2,4,13,14]. The lateral cephalogram determines the craniofacial anomalies. This method provides significant knowledge related to cranial, facial and oral structures. It may be a clinical sign of a genetic, congenital, or systemic disorders[6,9,12,15,16]. Many classification methods were performed for sella turcica types such as Meyer Marcotti or Camp JD[1,17] and Axelsson's et al's[3,14].

Sella turcica types have been reported in previous craniofacial and neurocranial morphologic studies[1,3,11,18,19]. In that studies the sella turcica abnormalities and variations have been also described in general[1,3,7,9-12,14,15,18-20]. However, some of them have been performed with healthy subjects or some orthodontic problems[3-6,10,12,15]. Morover, some papers have been done subjects having genetics problems such as Williams, syndrome, Axenfeld Rieger Syndrome, Down syndrome and Tip 1 diabetic syndrome[1,7,11,14,18,19]. Nevertheless, the results of age-dependent changes of the sella turcica types in studies have been no shown. So, this is an important morphometric study to investigate age and gender differences with sella turcica types in Turkish healthy population. In order to understand the abnormalities of sella turcica types and the effects of diseases related sella turcica, measurements of age and gender differences in normal healthy individuals should be well known to determine normal measurements. Therefore, in this study, it was aimed to determine the age and gender differences of sella turcica structures in healthy Turkish individuals using Lateral cephalometric radiographs.

## MATERIALS AND METHODS

This study was carried out from the 222 healthy subjects (93 females; 129 males) aged 1-46 years over a period of 3 years between January 2017 and 2019 September. This study was approved by the Cukurova University, Clinical Researches Ethics Committee, with Decision No:2017/69-19.

Our study was a retrospective observational study which was done in Medline Hospital, Department of Radiology in Adana-Turkey. Lateral cephalometric radiographs of the subjects were performed for evaluating the cranial. The main inclusion criteria were adult subjects who were no history of endocrine

disturbance, pregnancy, breast-feeding and adult subjects no taking hormone therapy (such as thyroid, estrogen, progesterone, steroid therapy) or are no on medication (such as phenothiazine or reserpine). The data were divided into two groups according to gender: healthy female and male subjects. Two classification methods named as Meyer Marcotti et al's classification, and Axellsson et al's classification were used to determine relation between gender and sella turcica types (Tables 1-2). Additionally, the classification methods were performed to evaluate age related changes. The data were divided also into five groups according to age; subjects aged between 1-10 years for Group 1 (n=81); 11-20 years for Group 2 (n=59); 21-30 years for Group 3 (n=57); 31-40 years for Group 4 (n=21); and 41-50 years for Group 5 (n=4) (Table 3-4).

## Statistical analysis

The measurements were made on the computer screen with an electonic caliper and estimations were expressed as millimeters. The SPSS 22.0 program was used for statistical analysis of the measurement results. In all statistical analyses; p value under 0.05 was considered as statistically significant. Chi-Square Test were also used for analyzing of cathegorical variables.

**Table 1. The comparison of the sella turcica types distribution by gender according to the Meyer Marcotti et al.'s classification method**

| Gender | Oval Type | Circular Type | Flat Type |
|---|---|---|---|
| Female (n=93) | 11 (%11.83) | 21 (%22.58) | 61 (%65.59) |
| Male (n=129) | 9 (%7.0) | 33 (%25.6) | 87 (%67.4) |
| Total (n=222) | 20 (%9.0) | 54 (%24.3) | 148 (%66.7) |
| P value | 0.441 | | |

**Table 2. The comparison of the sella turcica types distribution by gender according to the Axelsson et al.'s classification method**

| Gender | Normal sella turcica | Oblique anterior wall | Double contour of the floor | Sella turcica bridging | Irregularity (Notching) | Pyramidial shape of dorsum sellae | Variation combination |
|---|---|---|---|---|---|---|---|
| Females (n=93) | 56 (%60.2) | 13 (%14.0) | 1 (%1.1) | 2 (%2.2) | 20 (%21.5) | 1 (%1.1) | 0 (% 0) |
| Males (n=129) | 81 (%62.8) | 20 (%15.5) | 2 (%1.6) | 0 (%0.0) | 13 (%10.1) | 12 (%9.3) | 1 (%0.8) |
| Total (n=222) | 137 (%61.7) | 33 (%14.9) | 3 (%1.4) | 2 (%0.9) | 33 (%14.9) | 13 (%5.9) | 1 (%0.5) |
| P value | 0.023 | | | | | | |

**Table 3. The comparison of the sella turcica types distribution by age groups according to the Meyer-Marcotti et al.'s classification method**

| Disease Types | Meyer-Marcotti Classification | | | Total |
|---|---|---|---|---|
| | Oval type | Circular type | Flat type | |
| Decade 1 (1-10 years) | 12 (60.0%) | 27 (50.0%) | 42 (28.4%) | 81 (36.5%) |
| Decade 2 (11-20 years) | 4 (20.0%) | 11 (20.4%) | 44 (29.7%) | 59 (26.6%) |
| Decade 3 (21-30 years) | 4 (20.0%) | 12 (22.2%) | 41 (27.7%) | 57 (25.7%) |
| Decade 4 (31-40 years) | 0 (0.0%) | 2 (3.7%) | 19 (12.8%) | 21 (9.5% |
| Decade 5 (41-50 years) | 0 (0.0%) | 2 (3.7%) | 2 (1.4%) | 4 (1.8%) |
| P value | 0.021 | | | |

**Table 4. The comparison of the sella turcica types distribution by age groups according to the Axelsson et al.'s classification method**

| Disease Types | Axelsson et al's classification | | | | | | |
|---|---|---|---|---|---|---|---|
| | Normal sella turcica | Oblique anterior Wall | Double contour of the floor | Sella turcica bridging | Irregularity (Notching) | Pyramidial shape of dorsum sellae | Variation combination |
| Decade 1 (1-10 years) | 53 (%38.7) | 9 (27.3%) | 3 (%100) | 0 (%0,0) | 9 (27.3%) | 7 (53.8%) | 0 (%0;0) |
| Decade 2 (11-20 years) | 33 (24.1%) | 10 (30.3%) | 0 (%0,0) | 0 (%0,0) | 10 (30.3%) | 6 (46.2%) | 0 (%0,0) |
| Decade 3 (21-30 years) | 33 (24.1%) | 10 (30.3%) | 0 (%0,0) | 2 (100.0%) | 12 (36.4%) | 0 (0.0%) | 0 (%0,0) |
| Decade 4 (31-40 years) | 14 (%10.2) | 4 (12.1%) | 0 (%0,0) | 0 (0.0%) | 2 (6.1%) | 0 (0.0%) | 1 (100%) |
| Decade 5 (41-50 years) | 4 (2.9%) | 0 (0.0%) | 0 (%0,0) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (%0,0) |
| Total | 137 (100%) | 33 (100%) | 3 (100%) | 2 (100%) | 33 (100.0%) | 13 (100%) | 1 (%100.0) |
| P value | 0.062 | | | | | | |

## RESULTS

Sella turcica types were evaluated in 222 healthy subjects (93 females and 129 males) and were shown in Table 1 and 4. In sella turcica classification performed by Meyer Marcotti et al., the most seen sella turcica type was flat type both females (n=61; 65.59%) and males (n=87; 67.4%) (Table 1).

Also, in Axellsson et al's classification there were 56 normal sella turcica; 13 oblique anterior wall;1 double contour of the floor; 2 sella turcica bridging; 20 irregularity (notching); 1 pyramidial shape of dorsum sellae in females, respectively. Additionally, there were 81 normal sella turcica; 20 oblique anterior wall; 2 double contour of the floor; 13 irregularity (notching); 12 pyramidial shape of dorsum sellae and 1 variation combination in males, respectively (Table 2). While the least seen sella turcica type was double contour of the floor and pyramidial shape of dorsum sella, the variation combination sella turcica type was no seen in females according to Axellsson's et al. sella turcica classification. Also, in males, the least seen sella turcica type was the variation combination, whereas the sella turcica bridging was no found according to the same classification (Table 2).

In Meyer Marcotti et al's classification performed with different age groups, oval type and circular type were most seen in decade 1, whereas flat type was most seen in decade 2 (Table 3). According to Axelsson et al's classification, there were no found sella turcica bridging and variation combination in decade 1. However, the types of the double contour of the floor, sella turcica bridging and variation combination were no seen in decade 2. The most frequent seen type was normal sella turcica type (33), followed by irregularity (12), oblique anterior wall (10), sella turcica bridging (2) in decade 3.

The variation combination sella turcica type was seen only in decade 4. While only normal sella turcica type was seen in decade 5, there were no the other types such as oblique anterior wall, double contour of the floor, sella turcica bridging, irregularity or notching, pyramidial shape of dorsum sellae, and variation combination in decade 5 (Table 4).

## DISCUSSION

In this study, the sella turcica types in Turkish healthy individuals were analyzed according to age and gender and sella turcica types and variations were determined. Variations in the shape of sella turcica have long been reported by many researchers[2,3,6,7,12,14-16,21,22]. Also, many classifications were performed for sella turcica types. In classification method formed by Meyer Marcotti and/or Camp JD the sella turcica is classified into three types: oval, round, and flat[1,13,17,22,23]. Moreover, in a study of Gordon and Bell performed with healthy subjects aged between 1 and 12 years and categorized sella turcica into three shapes, circular, oval, flat/saucer shaped, it was reported that there were

circularly sella turcica shape in 35 males and 34 females; ovally sellae turcica shape in 11 males and 13 females; flattened sella turcica shape in 6 males and 4 females[22]. Additionally, in a study of Zagga et al's performed with 228 Nigerian healty subjects on lateral cephalometric radiographs, the most seen sella turcica types were oval [(83%; 145 males (84.8%) and 45 females (78.9%)], followed by circular [(11%; 17 males (9.9%) ;7 females (12.3%)), and flat (6%; 9 males (5.3%); 5 females (8.8%)][13].

Also, in a study performed by Zagga et al, it was reported that sella turcica types were seen in different ratios in children and adults population; 70% of sella turcica were circular in children, whereas in adults 24.4% were circular. However, 58% of all population were oval and 17.2% of all population were flat. Normally, the sella turcica had a high concave feature caused by what appears to be an excavation beneath the anterior clinoids. It was declared that was frequently described in children and had no pathological significance[13]. In a case report performed with Gorlin syndrome, in sella turcica abnormalities bridging appearance was reported, whereas, in healthy subjects, the sellar floor was usually flat or downwardly convex[13,18]. In this paper, the commonest sella turcica type was flat (66.7%), followed by circular (24.3%) and oval (9.0%). Additionally, in all decades from decade 1 to decade 5, the most frequent seen sella turcica type was flat type and the least seen type was oval. In decade 4 and 5, the oval type was no seen. According to Axelsson et al's classification method[3,14], sella turcica was categorized into six or seven types: normal sella turcica, oblique anterior wall, sella turcica bridging, double contour sella turcica, irregularity or notching, pyramidal shape of dorsum sella, and more than one type or variation combination[3,9,10,14-16]. In Norwegian 72 (35 males, 37 females) healthy subjects aged between 6 and 21 years, sella turcica morphology was found as normal in females (65%) and males (71%). Also, the commonest seen anatomic variation of sella turcica type was oblique anterior wall in males, bridging and irregularity or notching in females, respectively[3]. It has been reported that variation of the sella turcica type might be presented in healthy population as well as medically compromised patients such as spina bifida or craniofacial deviation[3,8,16,22]. Additionally, it was reported by Axellson et al in subjects with Williams Syndrome, specific morphological deviation of sella turcica occured more frequently and with greater severity[14]. In Iraq healthy subjects aged between 17-25 years, the normal type sella turcica was appeared to be higher in females (80.6%) than in males (71.4%). Additionally, the most frequent seen sella turcica shape was notching (7.9%) followed by pyramidal (6.3%), and double contour (6.3%) and oblique anterior wall (4.8) types in males, respectively. Moreover, in females the commonest variations of the sella turcica types were double contour (10.4%), notching (3%), and oblique anterior wall (3%) types[10]. Shah et al reported while the percentage of the normal sella turcica type was found as 66.1%, the commonest sella turcica variation was declared as irregularity (16.7%), followed by pyramidal shape (7.7%), double contour (5.5%), and oblique anterior wall (4.0%) in Pakistani population respectively[15]. The presence of sella turcica bridge in normal healthy individuals was reported as commonly seen, however there was rise in occurrence in patients having craniofacial deviation[2-4,15,16,18,23]. Furthermore, in 180 (90 females; 90 males) Saudi healthy subjects aged between 11-26 years, the sella turcica occurred with a normal morphology in the 66.7% of subjects regardless of gender. Variation in morphological appearance was present in 33,3 % of the individuals; an irregular dorsum sella was found in 11.1%, while an oblique anterior wall (9.4%) and a double-contoured sella turcica (8.9%) were present[16]. In the same study, the bridging sell turcica prevelance was approximately %5.5-22.0 in subjects without medically compromised. In addition, the another deviation of sella turcica shape was irregular sella turcica[1].

Bavbek and Dincer performed with 152 subjecs (76 Type 1 diabetic patients; and 76 healthy subjects) and reported that the measurements including sella were similar in the Type 1 diabetic and healhty subjects, but dysmorphologic types were more common in diabetic patients. Also, the normal sella turcica type was seen at rate of 55.3% and 78.9% in Tip 1 diabetic patients and healthy subjects, respectively. In Tip 1 diabetic patients, the commonest sella turcica variation was pyramidal shape (13.2%), followed by irregularity or notching (10.5%), oblique anterior wall (7.9%), and double contour (6.6%), respectively. the most prevalent sella turcica variation was oblique anterior wall (7.9%), pyramidal shape (6.6%), and irregularity (2.6%) and bridging (2.6%) respectively, whereas the double contour variation sella turcica was no seen in healthy subjects[19].

In 60 Saudi subjects with Down syndrome, there were normal sella turcica (45%); oblique anterior wall (33.3%); irregularity (20%); variation combination

(18.3%); bridging (11.7%); pyramidal shape (3%), and extreme low sella turcica (3.3%), respectively. In healthy subjects, there were normal sella turcica (63.3%); oblique anterior wall (20%); irregularity (11.7%); variation combination (1.7%); bridging (1.7%); and extreme low sella turcica (6.7%), respectively[11]. In Korayem and Alkofide's study, the significant differences were found between the groups (Down Syndrome and healthy subjects)[11]. In this study, there were normal sella turcica (60.2%); irregularity (21.5%); oblique anterior wall (14.0%); sella turcica bridging (2.2%); pyramidial shape of dorsum sellae (1.1%); and double contour of the floor (1.1%), respectively in females. In males, there were normal sella turcica (62.8%); oblique anterior wall (15.5%); irregularity (10.1%); pyramidial shape of dorsum sellae (9.3%); double contour of the floor (1.6%) and variation combination (0.8%), respectively. We determined that in one subject with hearing loss, the variation combination sella turcica type was seen and there were found normal sella turcica in three subjects having hearing loss. This result showed that the different sella turcica types may be seen in the same diseases as well. The ratios of the sella turcica variations were different between gender: variation combination were no found in females; whereas there were no found the sella turcica bridging in males.

Sella turcica is an crucial anatomic structure. The relationship between sella turcica morphology and systemic disorders may be reported by the similarity of the developmental origins of sella and those malformations[9]. During embryological development, the sella turcica and pituitary gland begin to occur at 7th week of gestation, the pituitary gland develops before the sella turcica. Accordingly, the anomaly of this region during fetal growth continues in whole life and also, sella turcica affect as well as pituitary gland. The formation of the pituitary gland during fetal life takes place ahead of the cartilaginous sella turcica. Thus, the pituitary gland development is closely correlated with the sella turcica[11].

Studies reported that morphological variations may be not indicated an anomaly at all times and morphological variations may be seen in healthy population and only these variations or anomalies may increase the frequency of prevalence of these morphological variations[9,14-16,23,24]. Kjaer reported that changes in cranial region are related with typical progressive deviations in sella turcica and pituitary gland morphometry[8]. Also, the similar type of malformation of the sella turcica happens to prenatal and postnatal periods in subjects having same diagnosis such as holoprosencephaly, cleft lip, cleft palate, Down syndrome and trisomy 21, spina bifida, myelomingocele, and fragile X syndrome and Meckel Gruber syndrome[3,7,11,14,19]. All these syndromes affect the size and morphology of the sella turcica during embryologic development. Also, the presence of severe anomaly may show the malformation of sella turcica[11]. For example, presence abnormal sella turcica in Down syndrome is described as; hypothyroidism, raised level of thyroid microsomal auto antibodies (proteins that attack the body's own tissue), and thyroid-stimulating hormone. Also, in males, an increase in serum androgen levels (sex chromosomal abnormality), in females, differences in serum estrogen, prolactin, and gonadotropin concentrations with normal population were stated[11]. Moreover, not only normal sella turcica type may be not seen in healthy subjects but also morphologic variations may be found. The normal sella turcica was less seen in Type 1 diabetic patients than healthy subjects[19]. Additionally, sella turcica bridging variation may show the severe sella turcica anomalies[1,20,23]. Sella turcica bridging may occur because of some causes; a malformation from prenatal life, some endocrinological and neurological disorders [2]. Studies were reported that the sella turcica size showed differences in healthy subjects than genetic disorder such as Down Syndrome and Williams Syndrome. Also, the sella turcica size may change according to gender or ages (puberty or post puberty). For this reason, this leads to more abnormalities or malformations in sella turcica shape[2,3,6,11,19,23]. Due to the closely relationships between sella turcica and pituitary gland, pituitary gland pathologies may affect the shape and/or size of sella turcica[4,25]. So, the subjects with abnormal sella turcica shape or larger-smaller pituitary gland may have underlying cause like Down Syndrome, Williams syndrome and other pituitary gland pathologies[2,4]. The pituitary gland tumor is one of the pituitary pathologies that produces abnormal hormones such as adrenocorticotropic hormone, prolactin, growth hormone, thyroid stimulating hormone, amenorrhea, acromegaly. A smaller pituitary gland causes the decreased pituitary function that leads to short stature, retarded skeletal growth[2,15,16,21]. Morover, the sella turcica anomalies may be preview of some significant mutations due to relation with craniofacial, dental aberrations (maxillary retrognathia, Class III skeletal, or teeth hypoplasia)

sella turcica morphology may change from person to person, between gender, age and genetic factors[1,2,4]. Therefore, we think that the factors such as age, gender, race, genetic or epigenetic factors and morphologic deviations can affect the sella turcica size, or morphology. As a result, many studies has been carried out relationships between sella turcica shape, variations and genetic diseases such as Down Syndrome, Fragile X syndrome and Turner syndrome.

In conclusion, these findings obtained healthy subjects may provide to occur the reference data and also help to detect the deviations of sella turcica even pituitary gland lesions. Alhough the sella turcica morphology may be affected by age, gender and diseases such as Down syndrome, Frajile X syndrome, or Williams syndrome, this study reveal that sella turcica variations may also seen in healthy population. Therefore, it is clear that the data obtained in this study will shed light on future clinical researches and evaluation of the diseases related to this critical region.

**Yazar Katkıları:** Çalışma konsepti/Tasarımı: SP, MÖ, AHY; Veri toplama: SP, AGK, FYÖ, MÖ; Veri analizi ve yorumlama: SP, MÖ, AHY; Yazı taslağı: SP, AGK, FYÖ, MÖ, AHY; İçeriğin eleştirel incelenmesi: SP, MÖ, AHY; Son onay ve sorumluluk: SP, AGK, FYÖ, MÖ, AHY; Teknik ve malzeme desteği: SP, AGK, FYÖ, MÖ, AHY; Süpervizyon: SP, MÖ, AHY; Fon sağlama (mevcut ise): yok.
**Etik onay:** Çukurova Üniversitesi Tıp Fakültesi Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu 06.10.2017 tarih ve 69 sayılı kararı ile onay almıştır.
**Hakem Değerlendirmesi:** Dış bağımsız.
**Çıkar Çatışması:** Yazarlar çıkar çatışması beyan etmemişlerdir.
**Finansal Destek:** Bu çalışma Çukurova Üniversitesi Bilimsel Araştırma Projeleri Koordinasyon Birimi (Proje numarası: TSA-2018-11285) tarafından desteklenmiştir.
**Yazarın Notu:** Bu çalışma, 27-31 Ağustos 2019 tarihleri arasında İstanbul, Türkiye'de düzenlenen 20. Ulusal Anatomi Kongresi'nde sözlü sunum olarak sunulmuştur.

**Author Contributions:** Concept/Design : SP, MÖ, AHY; Data acquisition: SP, AGK, FYÖ, MÖ; Data analysis and interpretation: SP, MÖ, AHY; Drafting manuscript: SP, AGK, FYÖ, MÖ, AHY; Critical revision of manuscript: SP, MÖ, AHY; Final approval and accountability: SP, AGK, FYÖ, MÖ, AHY; Technical or material support: SP, AGK, FYÖ, MÖ, AHY; Supervision: SP, MÖ, AHY; Securing funding (if available): n/a.
**Ettical approval:** Cukurova University Faculty of Medicine non-interventional clinical research ethics committee has been approved by decision no.69 of 06.10.2017.
**Peer-review:** Externally peer-reviewed.
**Conflict of Interest:** Authors declared no conflict of interest.
**Financial Disclosure:** This study was supported by a grant from Cukurova University Scientific Research Projects Coordination Unit (Project number: TSA-2018-11285).
**Author Note:** This study was partly presented as oral presentation at the 20th National Anatomy Congress, Istanbul/ Turkey, 27th– 31st August, 2019.

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