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Research Article

Sex-Related Changes in the Configuration of the Ethmoid Roof and Evaluation of Asymmetry

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Abstract

Objective: The aims of this study were to investigate the information about cribriform plate depth in comparison to the ethmoid roof, to describe the relationship between these dimensions and adjacent some anatomic structures and to seek possible sex and age factors through coronal section in Turkish population.

Materials and Methods: The study included paranasal sinus computed tomography scans of 300 patients. The depth and anatomical variations of the ethmoid roof can be detected only in coronal sections. Therefore, study measurements performed bilaterally on the previously described coronal section where cribriform plate is seen the deepest by using a 6-slice Multidetector Computed Tomography scanner. Comparative measurements between the sides were analyzed.

Results: There were significant differences between the right and left sides' in terms of the cribriform plate depth, the distance between the ethmoid roof and nasal floor, and the vertical length of middle turbinate. There were significant differences between the distance between the ethmoid roof and nasal floor, medial foveal angle, the distance between suprahorizontal line and cribriform plate and maximal height of orbit in vertical plane in terms of Keros types for right sides. There were significant differences between the distance between the ethmoid roof and the nasal floor, and medial foveal angle in terms of Keros types for left sides. The cribriform plate depth was higher on the left side in 179 (59.7%) patients and higher on the right side in 121 (40.3%) patients.

Conclusion: The distance between the ethmoid roof and nasal base shows significant increase, and medial foveal angle shows significant decrease with Keros type 1 to 3. Our study suggests that these significant results should be considered when comparing medial foveal angle with gender and Keros types before endoscopic sinus surgery.

Keywords: *Asymmetry; Cribriform Plate; Computed Tomography; Ethmoid Roof; Paranasal Sinus*

Introduction

Nowadays, endoscopic sinus surgery (ESS) is widely performed for the management of sinonasal pathologies like tumors, infections and various pathologies by surgeons [1]. Cerebrospinal fluid (CSF) leakage due to anterior skull base injury is one of the most important complications of ESS and it is related to the complex anatomy of the ethmoid roof. Therefore, the surgeons should be aware of the crucial complex anatomy of the anterior skull base to avoid the minor and major complications during the surgery [2,3].

The ethmoid roof is one of the anatomical structures that composes the anterior skull base. Fovea ethmoidalis, one of the parts of frontal bone, comprises lateral part of the ethmoid roof. The roof of ethmoidal labyrinth is formed by the fovea ethmoidalis. Also, lateral lamella of the cribriform plate (CP), the most vulnerable bone of the skull base, comprises medial part of the ethmoid roof. Anatomical structure of the ethmoid roof can be highly variable even between the different sides of same person [1,2,4].

The relationship between CP and ethmoid roof was classified by Keros with cadaveric study and he described three categories. In type 1, CP depth is 1 - 3 mm, thin lateral lamella is short and the sinus less dangerous to operate within. In type 2, CP depth is 4 - 7 mm. In type 3, CP depth is > 7 mm deep, thin lateral lamella is very long, and it forms a larger part of the ethmoid roof. Therefore, type 3 is the most vulnerable type in terms of complications during operation [1-3,5,6].

Paranasal sinus computerized tomography (CT) is one of the most important imaging techniques to provide detailed data of the paranasal sinus anatomy and its variability and to evaluate sinonasal diseases [3]. Detailed evaluation of the patient's CT scan before the operation is very crucial for surgical safety and avoiding the possible intracranial complications [1,2].

Aim of the Study

The aims of this study were to investigate the information about CP depth in comparison to the ethmoid roof, to describe the relationship between these dimensions and adjacent anatomic structures such as the distance between the ethmoid roof and nasal floor, medial foveal angle, the vertical length of the middle turbinate, the distance between suprahorizontal line and CP, maximal height of orbit in vertical plane, and to seek possible sex and age factors through coronal section in a larger sample of Turkish population.

Materials and Methods

Patients

Afyon Kocatepe University Board of Non-Invasive Clinical Researches approved the study (September 06, 2012, 2012-5-39). This study retrospectively included the coronal section paranasal sinus CT scans of 300 (147 female, 153 male) patients referred to Afyon Kocatepe University, School of Medicine, Departments of Otorhinolaryngology, Neurology and Ophthalmology, with the complaints of headache, runny nose, nasal obstruction and sinusitis, ranging in age from 20 to 70 years old.

The CT scan images between 2005 and 2012 were collected from the CT scan image archives of the Radiology Department. Socio-demographic parameters such as age and sex of all patients were obtained from the archive files from the Radiology Department. Exclusion criteria were severe paranasal sinusitis, sinonasal polyp or tumour, previous history of surgery or trauma in the paranasal sinuses and skull base and patient age under 20 years. 6-Slice Multidetector CT scanner (MD-CT) (Philips Brilliance 6, Philips Medical Systems, Amsterdam, Holland) was used.

Measurements

Measurements, using the distance-measurement tool were taken in the first coronal cut that clearly showed the deepest CP [2]. The CP depth, distance between the ethmoid roof and nasal floor, medial foveal angle, the vertical length of the middle turbinate, the distance between suprahorizontal line and CP, and maximal height of orbit in vertical plane were measured bilaterally (Figure 1). The distribution of Keros classification according to age and sex was evaluated. Comparative measurements between the sides were analyzed.

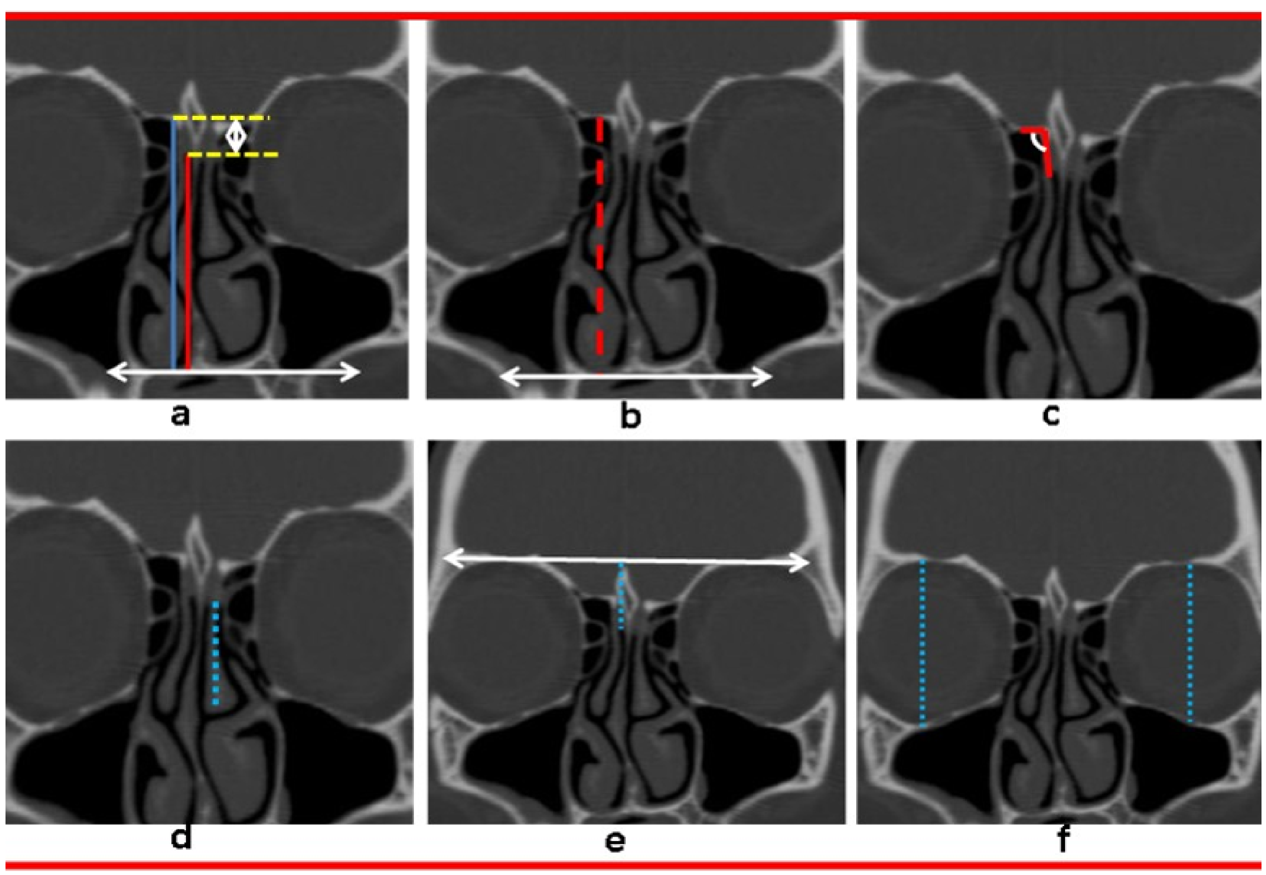

Figure 1: *A schematic illustration of coronal MD-CT image. Measurements presented unilaterally. a) the depth of cribriform plate (CP) (between yellow dotted line), b) the distance between the ethmoid roof and nasal floor (red dotted line), c) medial foveal angle, d) the vertical length of the middle turbinate (blue dotted line), e) the distance between suprahorizontal line and CP (blue dotted line) and f) maximal height of orbit in vertical plane (blue dotted lines).*

The measurement of the depth of CP was shown in figure 1a. The depth of CP was measured by distance from the medial ethmoidal roof point to deepest point of the CP. For this, nasal floor was determined as a reference point (long white arrow). The distance between medial ethmoidal roof point and nasal floor was measured (blue line (A)). Then, the distance between the deepest point of the CP and nasal floor was measured as well (red line (B)). CP depth was calculated by subtracting the B from A (short white arrow) (Figure 1a). Distance between the ethmoid roof and nasal floor was measured by the distance from the middle of the highest point of the ethmoid roof to nasal floor (red dotted line) (Figure 1b). The medial foveal angle which is angulation between medial point of the fovea ethmoidalis and medial foveal wall (lateral lamella of CP) was measured (Figure 1c). The vertical length of the middle turbinate was measured by distance from the location where the middle turbinate adhered to the skull base and inferior point of the middle turbinate (blue dotted line) (Figure 1d). To measure the distance between suprahorizontal line and CP, horizontal line passing through the right and left supraorbital margin were drawn (white arrow). The distance between CP and this line was measured (blue dotted line) (Figure 1e). Vertical distance between supraorbital and infraorbital margins was measured for maximal height of orbit in vertical plane. The coronal cut that showed the largest orbital distance was used for this measurement (blue dotted line) (Figure 1f). The asymmetry was calculated by subtracting the CP depths from each side in same patient. Three groups were determined according to difference between the two sides as < 1 mm, 1-2 mm, and >2 mm respectively [2,3,7].

The measurements were performed twice at different times by the same person and were averaged for these counts (intra-observer reliability). In addition, the measurements of all MR images were measured by two researchers independently. There was no significant difference between the measurements of the two researchers (inter-observer reliability). Therefore, the mean values of these two measurements were used.

Statistical Methods

Statistical analyses were performed using the SPSS software version 20.0. The variables were investigated using visual (histograms, probability plots) and analytical methods (Kolmogorov-Smirnov or Shapiro-Wilk's test) to determine whether they were normally distributed or not. Descriptive analyses were presented using means and standard deviations for normally distributed. Independent t-test was used for comparison of continuous variables. The data, not showing normal distribution, was evaluated by using Mann-Whitney U Test. ANOVA test was used for comparison of more than two groups. When an overall significance was observed, pairwise post-hoc tests were performed using Tukey's test. Chi-square test was used to compare discrete variables among groups. An overall p-value of less than 0.05 was considered to show a statistically significant result.

Results and Discussion

The MD-CT scans from 300 patients (147 female, 153 male) were evaluated. Mean age of the patients was 42.4 ± 13.8 years. In the 3rd, 4th, 5th, 6th and 7th decades, there were 66 (32 F, 34 M), 66 (32 F, 34 M), 64 (31 F, 33 M), 64 (32 F, 32 M) and 40 (20 F, 20 M) people, respectively. There was no statistically significant difference between groups ($p > 0.05$).

Keros Types

The distribution of Keros classification according to sex was analyzed right and left sides separately. The mean right CP depth was 5.3 ± 2.00 mm, and left CP depth was 5.8 ± 2.2 mm. No statistically significant difference was observed in the CP depth on both sides between sex and age ($p > 0.05$). Table 1 shows the distribution of Keros types of cases according to sex and sides (in number and percentage). When 600 sides were analyzed according to the Keros classification, the most common type was Keros type 2 (51.3%), followed by Keros type 1 (24.8%) and Keros type 3 (23.8%).

Types	Female number (%*) Right/Left	Male number (%*) Right/Left	Total number (%*) Right/Left	Average percentage Total
Keros1	46 (31.3)/39 (26.5)	35 (22.9)/29 (19.0)	81 (27.0)/68 (22.6)	24.8%
Keros2	79 (53.7)/72 (49.0)	82 (53.6)/75 (49.0)	161 (53.6)/147 (49.0)	51.3%
Keros3	22 (15.0)/36 (24.5)	36 (23.5)/49 (32.0)	58 (19.3)/85 (28.3)	23.8%
Total	147/147	153/153	300/300	

Table 1: *The distribution of Keros types according to sex for right and left side.*

Measurements

The CP depth, distance between the ethmoid roof and nasal floor, the vertical length of the middle turbinate, medial foveal angle, distance between suprahorizontal line and CP, and the maximal height of orbit in vertical plane according to sex summarized in table 2-4 for both sides. According to table 2, CP depth, the distance between the ethmoid roof and nasal floor, the vertical length of middle turbinate and maximal height of orbit in vertical plane were statistically significant difference in male and female patients for the right side (p were 0.03, < 0.001, 0.03 and < 0.001 respectively). These parameters were higher in males. According to table 3, the distance between the ethmoid roof and nasal floor, medial foveal angle and maximal height of orbit in vertical plane were statistically significant difference in male and female patients for the left side (p were < 0.001, 0.006, < 0.001 respectively). When 600 sides were analyzed without taking sex into account, there were significant differences between the right and left sides' in terms of the CP depth, the distance between the ethmoid roof and nasal floor, and the vertical length of middle turbinate (p were 0.007, 0.04, and 0.04 respectively) (Table 4). There were no significant differences in the other parameters statistically.

Measurements (Right)	Mean		Standard Deviation		
	Female (147)	Male (153)	Female	Male	P value
The CP Depth (mm)	5.00	5.50	2.00	2.10	0.03
The distance between the ethmoid roof and nasal floor (mm)	52.57	56.81	3.89	4.64	< 0.001
The vertical length of middle turbinate (mm)	23.23	24.16	3.84	3.87	0.03
The Medial foveal angle (º)	116.50	111.85	21.03	20.20	NS
The distance between suprahorizontal line and CP (mm)	14.74	14.97	2.08	2.49	NS
The maximal height of orbit in vertical plane (mm)	38.04	40.13	1.86	1.97	< 0.001

Table 2: *The gender comparations of the CP depth, the distance between the ethmoid roof and nasal floor, the vertical length of the middle turbinate, the medial foveal angle, the distance between suprahorizontal line and CP, and maximal height of orbit in vertical plane on the right side.*
NS: Not Significant.

Measurements (Left)	Mean		Standard Deviation		
	Female (147)	Male (153)	Female	Male	p Value
The CP Depth (mm)	5.50	6.00	2.20	2.30	NS
The distance between the ethmoid roof and nasal floor (mm)	53.30	57.63	4.14	4.77	< 0.001
The vertical length of middle turbinate (mm)	24.07	24.60	3.61	3.87	NS
The medial foveal angle (º)	118.14	111.99	18.34	20.00	0.006
The distance between suprahorizontal line and CP (mm)	14.51	14.65	2.19	2.55	NS
The maximal height of orbit in vertical plane (mm)	37.73	39.80	2.19	1.93	< 0.001

Table 3: *The gender comparations of the CP depth, the distance between the ethmoid roof and nasal floor, the vertical length of the middle turbinate, medial foveal angle, the distance between suprahorizontal line and CP, maximal height of orbit in vertical plane on the left side.*
NS: Not Significant.

Measurements	Mean		Standard Deviation		
	Right (n:300)	Left (n:300)	Right	Left	p Value
CP Depth (mm)	5.30	5.80	2.00	2.20	0.007
The distance between the ethmoid roof and nasal floor (mm)	54.73	55.50	4.70	4.90	0.04
The vertical length of middle turbinate (mm)	23.70	24.34	3.80	3.70	0.04
Medial foveal angle (º)	114.13	115.00	20.70	19.42	NS
The distance between suprahorizontal line and CP (mm)	14.86	14.58	2.30	2.30	NS
Maximal height of orbit in vertical plane (mm)	39.10	38.79	2.10	2.30	NS

Table 4: *The comparison of the means of the CP depth, the distance between the ethmoid roof and nasal floor, the vertical length of the middle turbinate, medial foveal angle, the distance between suprahorizontal line and CP, maximal height of orbit in vertical plane in right and left sides.*
NS: Not Significant.

The relationship between Keros classification and our measurements was analyzed for both sides. There were significant differences between the distance between the ethmoid roof and nasal floor, medial foveal angle, the distance between suprahorizontal line and CP, and maximal height of orbit in vertical plane in terms of Keros types for right sides (p were < 0.001, < 0.001, 0.01 and < 0.001 respectively) (Table 5). As the predominance, "the distance between the ethmoid roof and the nasal floor" was the largest in the Keros type 3 group, while, in the Keros type 1 group, the "medial foveal angle" was the largest. There were significant differences between the distance between the ethmoid roof and the nasal floor, and medial foveal angle in terms of Keros types for left sides (p were < 0.001 and < 0.001 respectively) (Table 6).

Right	Mean			P value
	Keros1	Keros2	Keros3	
The distance between the ethmoid roof and nasal floor (mm)	52.65 ± 4.4	54.53 ± 4.1	58.20 ± 4.9	< 0.001
The vertical length of middle turbinate (mm)	23.77 ± 3.8	23.57 ± 3.7	24.00 ± 4.2	NS
Medial foveal angle (º)	123.8 ± 20.9	113.2 ± 19.7	103.4 ± 16.9	< 0.001
The distance between suprahorizontal line and CP (mm)	14.25 ± 2.3	15.11 ± 2.2	15.00 ± 2.1	0.01
Maximal height of orbit in vertical plane (mm)	38.35 ± 1.9	39.30 ± 2.1	39.60 ± 2.2	0.001

Table 5: *The comparisons of the distance between the ethmoid roof and nasal floor, the vertical length of the middle turbinate, medial foveal angle, the distance between suprahorizontal line and CP, maximal height of orbit in vertical plane in right side according to Keros classification.*
NS: Not Significant.

Left	Mean			P value
	Keros1	Keros2	Keros3	
The distance between the ethmoid roof and nasal floor (mm)	52.18 ± 4.2	55.44 ± 4.3	58.27 ± 4.8	< 0.001
The vertical length of middle turbinate (mm)	24.29 ± 3.4	24.30 ± 3.7	24.45 ± 4.0	NS
Medial foveal angle (º)	124.0 ± 21.2	116.0 ± 16.9	106.1 ± 18.2	<0 .001
The distance between suprahorizontal line and CP (mm)	14.45 ± 2.3	14.48 ± 2.4	14.87 ± 2.3	NS
Maximal height of orbit in vertical plane (mm)	38.24 ± 2.8	38.94 ± 2.0	38.96 ± 2.1	NS

Table 6: *The comparison of the distance between the ethmoid roof and nasal floor, the vertical length of the middle turbinate, medial foveal angle, the distance between suprahorizontal line and CP, maximal height of orbit in vertical plane in left side according to Keros classification.*
NS: Not Significant.

When comparing the differences in the CP depth in the same sections, difference < 1 mm between two sides was found in 116 (38.6%) patients, difference of 1 - 2 mm between two sides was found in 92 (30.7%) patients and difference > 2 mm between two sides was found in 92 (30.7%) patients. Overall, the CP depth was higher on the left side in 179 (59.7%) patients and higher on the right side in 121 (40.3%) patients.

The development of ESS in the 1980s and imaging techniques have been increased the correctness of diagnosis and treatment of diseases of the paranasal sinuses. Many previous surgical procedures were changed with the introduction of the endoscopic techniques into paranasal sinus surgery as in many major fields of otolaryngology. Increasing use of these endoscopic procedures also led to an increase in the frequency of complications belonging to this process. The risk of intracranial damage is high in this area during surgery. One of the most important complications of ESS is CSF leakage due to anterior skull base injury yet. Similar studies were done in different parts of the world analyzing the configuration of the ethmoid roof according to Keros classification [2,3,5].

In our study, we found the mean CP depth as 5.3 mm in right and 5.8 mm in left sides. In the previous studies about CP depth in the literature were given in table 7. According to this table, there is a great heterogeneity between the data. It is hard for us to discuss the reasons for this. But we can say that our findings were consistent with studies of Basak., *et al*, Meloni., *et al.* and Adeel., *et al*. Along with that, it is important to note that measurements of Basak., *et al.* are in the pediatric age group.

Literatures	Number	CP depth (mm) Right/Left	Keros Types (%) 1/2/3
Adeel., *et al.* [1]	77	5.5/5.2	29.8/48.7/21.4
Alazzawi., *et al.* [2]	150	2.6	80/20/0
Ali., *et al.* [13]	75		20/78.7/1.3
Anderhuber., *et al.* [14]	272		14.2/70.6/15.2
Arslan., *et al.* [8]		8/9.5	
Basak., *et al.* [9]	64	5.3/5.3	9/53/38
Erdem., *et al.* [3]	136	6.1/6.1	8.1/59.6/32.3
Erdogan., *et al.* [15]			10/67.7/22.3
Guler., *et al.* [5]	300	4.5/4.4	26/66/8
Jang [16]	205		30.5/69.5/0
Keros [6]	450		12 /70/18
Meloni., *et al.* [10]		5.9	
Nair., *et al.* [17]	180		17.2/77.2/5.6
Nitinavakarn., *et al.* [18]	88		11.9/68.8/19.3
Nouraei., *et al.* [19]	278		92/7 /1
Sahin., *et al.* [11]	100	6.2/6	10/61/29
Solares., *et al.* [12]	50	6.2	83/15/2
Souza., *et al.* [4]	200		26.2/73.3/0.5
Currently study	300	5.3/5.8	24.8/51.3/23.8

Table 7: *Depth of cribriform plate (mm) and percentage of Keros classification with literature.*

Keros analyzed 450 skulls to configure the ethmoid roof according to the depth of the lateral wall of the cribriform layer in 1962. The relationship between the CP depth and ethmoid roof was classified into three types. He found 12% of the cases as Keros Type 1 (< 4 mm), 70% of the cases as Keros Type 2 (4 - 7 mm) and 18% of the cases as Keros Type 3 (> 7 mm). According to Keros, the skull base is most likely to be damaged during ESS in Keros Type 3 cases compared to other types because of the high penetration possibility through the lateral lamella of the CP which is the thinnest part of the ethmoid roof [6]. In our study, we found that the most common type was Keros type 2 (51.3%), followed by Keros type 1 (24.8%) and Keros type 3 (23.8%). In the previous studies about Keros types in the literature were given in table 7. According to this table, there is a great heterogeneity between the data, too. It is hard for us to discuss the reasons for this. Our findings were relatively consistent with studies of Adeel., *et al*, Basak., *et al,* Erdem., *et al. and* Sahin., *et al.*

In our study, the asymmetry of CP depth between the opposite sides in the same patient was evaluated. The differences < 1 mm between right and left side were seen in 38.6%, 1 - 2 mm was seen in 30.7% and > 2 mm was seen in 30.7% of all cases (61.4% totally). No statistically significant difference between sex and asymmetry was found. Overall, the higher CP depth on the left side was seen in 179 (59.7%) patients and higher on the right side was seen in 121 (40.3%) patients. The asymmetry of CP depth between the opposite sides in the same patient was also evaluated. Many studies showed that the mean CP depth on the left side was higher than the right side

[3,6,10,20,21]. Sahin., *et al.* evaluated olfactory fossa height and fovea contour asymmetry and they found olfactory fossa height asymmetry in 19% of the cases, fovea contour asymmetry in 37% of the cases, both height and contour asymmetry in 12% of the cases [11]. Erdem., *et al.* observed asymmetry in 51.5% of the cases. They also evaluated the relationship between asymmetry and Keros classification in their study [3]. Guler., *et al.* evaluated olfactory fossa height and fovea contour asymmetry and they observed olfactory fossa height asymmetry in 0.09% of the cases, fovea contour asymmetry in 29% of the cases, both height and contour asymmetry in 0.05% of the cases [5]. Alazzawi., *et al.* found asymmetry in 93% of the cases. They also found CP depth on the left side was high in 51% of the cases and it was high in 49% of the cases on the right side [2]. Reiss and Reiss, in a review of 644 cases, observed asymmetry in 34% of the cases. They found greater CP height on the left side in 25% and greater CP height on the right side in 9% of the asymmetric cases. They also showed that there was a significant difference between sex and asymmetry [22]. Souza., *et al.* found asymmetry in 12% of the cases. They found higher lateral lamella on the left side in 54.1% and on the right side in 45.8% of the asymmetric cases [4]. Solares., *et al.* observed asymmetry in all cases. Greater CP height on the left side was seen in 44% of the cases and greater CP height on the right side was seen in 56% of the cases [12]. Adeel., *et al.* found asymmetry in all cases. They observed that there was greater CP height on the left side in 54.5% and greater CP height on the right side in 40.2% of all cases [1]. Dessi., *et al.* found asymmetry in 10% of the cases [20]. Lebowitz., *et al.* found asymmetry in 9.5% of the cases. Our results showed partial similarity with the literature [21].

In our study, there was significant difference between the distance betwixt ethmoid roof and nasal base and Keros classification in both sides. It was seen that the distance was the lowest in Keros1 and the highest in Keros3 cases in both sides. The distance was higher in male than female patients in both sides. Erdem., *et al.* evaluated the distance between ethmoid roof and nasal base according to Keros classification [3]. They found that the distance was statistically the lowest in Keros1 and the highest in Keros3 cases. Erdem's findings were similar to our findings. We think that more care should be taken when performing ESS in men.

In our study, it was found that the vertical length of the middle turbinate was greater on the left side than right side. It was also analyzed that the distance was greater in male than female on the right side. There was no statistically significant difference between the vertical length of the middle turbinate and Keros classification. The middle turbinate is one of the most important anatomic reference points in the ESS. Erdem., *et al.* found that the vertical length of the middle turbinate was significantly the greatest in Keros1 and there was no sex difference [3]. Sahin., *et al.* found that the vertical length of the middle turbinate was greater in Keros1 than other Keros types [11]. Guler., *et al.* found that there was statistically significant difference between patients with mucosal changes and patients without it in Keros3 cases in terms of the vertical length of the middle turbinate [5]. These dimensions of middle turbinate, which is an important landmark for surgery, should be taken into account especially when working on the right side. Orbita is one of the most important anatomic structures in ESS. In our study, it was found that the maximal height of orbit in vertical plane was statistically greater in male than female in both sides. There was no statistically significant difference between right and left sides. It was the shortest in Keros1 cases than other Keros types in right side. Erdem., *et al.* did not find statistically significant difference between maximal height of orbita in vertical plane and both sex and sides [3]. However, Guler., *et al.* found that there was statistically significant difference between patients with mucosal changes and patients without mucosal changes in both sexes in terms of the maximal height of orbit [5].

In our study, there was no statistically significant difference between right and left sides in terms of the distance between suprahorizontal line and CP both female and male patients. In our study, medial foveal angle was statistically narrower in male than women in left side. It was narrower in male than women in right side, but it was not statistically significant. The angle was the largest in Keros type 1 cases and the narrowest in Keros type 3 cases in both sides.

In our literature review, the studies about variations of fovea contour asymmetry were found but there was no study about the measurement of medial foveal angle. Comparison of medial foveal angle with both sexes and Keros types yielded significant results. We think that this is an important outcome of our study which should be considered by the surgeons before ESS.

Conclusion

Comprehension of the ethmoid roof anatomy variations give the surgeon optimal information about the possible risk that one can face during the surgery. Therefore, knowing these variations is very important in the ESS and surgeons can be avoided dreadful complications in this way.

The result of higher CP depth and narrower medial foveal angle in male may show that the risks of complications can be higher in male than female.

The distance between the ethmoid roof and nasal base shows significant increase, and medial foveal angle shows significant decrease with Keros type 1 to 3. Our study suggests that these significant results should be considered when comparing medial foveal angle with gender and Keros types before endoscopic sinus surgery.

Our data were obtained from patients who either lived in urban and rural areas, and we considered our patients to form a cross-section of the Turkish population. While there have been many studies on variations of the ethmoid roof, few studies were observed considered ethnic differences. Perhaps it would be useful to do separate studies involving meta-analyzes.

Authorship Contribution

The authors of this paper indicated in the title made substantial contributions to the following tasks of research: initial conception and design (A.S., H.G., A.A.); administrative, technical or material support (A.S., H.G., A.A., Y.G., O.T., E.K., A.C., H.U.T.); acquisition of data (A.S., H.G., A.C., H.U.T.); laboratory analysis and interpretation of data (A.S., H.G., A.A., Y.G., O.T., E.K., A.C., H.U.T.); drafting of the manuscript (A.S., H.G., A.A., Y.G., O.T., E.K., A.C.); critical revision of the manuscript for important intellectual content (A.S., H.G., A.A., Y.G., O.T., E.K., A.C., H.U.T.). The views expressed herein are those of the authors and not necessarily their institutions or sources of support.

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