Ethmoid roof radiology; analysis of lateral lamella of cribriform plate

Radiologiczna ocena stropu komórek sitowych – analiza płytki bocznej blaszki sitowej

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ABSTRACT: Objective: We evaluated the extent of asymmetry evident in paranasal sinus computed tomography (CT) scans of Turkish patients without sinusitis in the ethmoid roof. Our data contribute to the body of knowledge on the subject.

Materials and Methods: We retrospectively studied multiplanar reformatted CT images of the paranasal sinus (1-mm sections) from 110 patients (50 male, 60 female). Ethmoid roof variations on either side were compared and the lateral lamellar length of the cribriform plate was measured. The results were scored using the Keros classification.

Results: The lateral lamella of the cribriform plate averaged 5.78 mm in height on the right side and 5.98 mm on the left. The most common Keros type was type 2 (67.72%), followed by type 3 (22.28%), and type 1 (10%). Keros asymmetry (≥ 0.01 mm, affecting either side) was apparent in all patients (48.2% right-sided and 51.8% left-sided).

Results: Preoperatively, paranasal sinus CT scans should be evaluated carefully to eliminate the possibility of life-threatening complications, including intracranial trauma, which may develop during endoscopic sinus surgery; the left and right sides of the ethmoid roof may differ in depth.

KEYWORDS: anatomical variations of the ethmoid roof, Keros classification, computed tomography

STRESZCZENIE: Cel: Oceniano stopień asymetrii stropu komórek sitowych widoczny w obrazach tomografii komputerowej (TK) zatok przynosowych pacjentów tureckich bez zapalenia zatok.

Materiał i metody: Przeprowadzono retrospektywną ocenę obrazów TK zatok przynosowych z rekonstrukcją wielopłaszczyznową (warstwy 1 mm) u 110 pacjentów (50 mężczyzn i 60 kobiet). Porównano odmienności budowy stropu komórek sitowych po obu stronach oraz mierzono długość płytki bocznej blaszki sitowej. Wyniki oceniano za pomocą klasyfikacji Kerosa.

Wyniki: Wysokość płytki bocznej blaszki sitowej wynosiła średnio 5,78 mm po stronie prawej i 5,98 mm po stronie lewej. Najczęstszy, według klasyfikacji Kerosa, był typ 2 (67,72%), następnie typ 3 (22,28%) i typ 1 (10%). Zgodna z klasyfikacją Keros asymetria (≥ 0,01 mm, dotycząca którejkolwiek ze stron) była widoczna u wszystkich pacjentów (48,2% po stronie prawej i 51,8% po stronie lewej).

Wnioski: Przed operacją należy dokładnie ocenić obraz tomografii komputerowej zatok przynosowych, aby wyeliminować możliwość zagrażających życiu powikłań, w tym urazu śródczaszkowego, który może wystąpić w czasie endoskopowej operacji zatok. Lewa i prawa strona stropu komórek sitowych mogą różnić się głębokością.

SŁOWA KLUCZOWE: odmienności budowy anatomicznej stropu komórek sitowych, klasyfikacja Kerosa, tomografia komputerowa
INTRODUCTION

History-taking and physical examination should always be the first steps when evaluating a patient with paranasal sinus disease, but these may not always provide us with adequate diagnostic information. Computed tomography (CT) readily reveals fine anatomical structures, cells in the anterior and middle ethmoidal regions, any frontal recess, osteomeatal details, mucosal pathology, and anatomical variation. CT can also reveal pathologies (1, 2, 3). The human sinonasal region is very variable, and anatomical changes play important roles in the pathogenesis of sinus inflammation (4, 5). Therefore, CT should be used to evaluate the nasal region prior to functional endoscopic sinus surgery (FESS). Coronal CT optimally reveals sinus pathology (6) and has markedly improved FESS success rates (1, 5, 7, 8, 9). CT not only reveals the presence but also the extent of sinus disease as well as anatomical variations, thus providing the surgeon with invaluable guidance (10). Serious complications may arise if paranasal sinus anatomy, particularly that of the ethmoid roof, is not taken into consideration. The Keros system defines three types according to the distance between the cribriform plate and the lateral lamella: type 1, 1-3 mm; type 2, 4-7 mm; and type 3, 8-16 mm (11). The type 3 ethmoid roof is weak, and the cribriform plate of the ethmoid skull base, which forms a large part of the roof, is less protected than in the other Keros types. Therefore, type 3 patients are more susceptible to iatrogenic complications.

We studied patients in terms of anatomical variation of the ethmoid roof and evaluated the usefulness of preoperative CT to prevent intracranial and orbital complications. Our data emphasize the need for further work in this area.

MATERIALS AND METHODS

This study was approved by the Ethics Committee of Kocaeli University, Kocaeli. We examined paranasal sinus CT images taken between January 1 and October 2, 2012 (Toshiba Aquilion 64). Cross-sectional images 1 mm in depth were taken. The CT parameters were 120 kV and 100 mA. Axial, coronal, and sagittal images were collected, axial slices reconstructed using OsiriX software, and all measurements re-calculated.

No evidence of sinusitis was apparent in 451 patients presenting between the dates specified above. Exclusion criteria were any nasal polyp or tumor, severe paranasal sinusitis, any prior operation on the paranasal sinuses, and age less than 18 years. Finally, 110 patients were enrolled in the study and CT images of the ethmoid roof were examined in terms of anatomical variation.

Measurements on the cribriform plate (CP) and the infraorbital nerve entry and exit points were made with reference to the medial point of the ethmoid roof (MERP) (Figure 1 A-B and C). Measurements were made in the coronal plane in the deepest region of the cribriform layer. In terms of the infraorbital nerve, the MERP is the point where a horizontal plane intersects with the exit point of the infraorbital nerve from the cribriform plate, and vertical distances were measured from this horizontal plane. The height of each lateral lamella of the cribriform plate (LLCP) was calculated by subtracting this distance from the overall measurement (Figure 1D). Keros classifications were examined in terms of both sex and asymmetry.

RESULTS

The average patient age was 43 years (range: 18-81 years). Fifty patients (45.45%) were male and 60 (54.55%) were female. The

<table>
<thead>
<tr>
<th>KEROS TYPE</th>
<th>NUMBER (N:220)</th>
<th>PERCENTAGE (%)</th>
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<tbody>
<tr>
<td>Keros type 1 (0-3,99 mm)</td>
<td>22</td>
<td>10</td>
</tr>
<tr>
<td>Keros type 2 (4-7 mm)</td>
<td>149</td>
<td>67.7</td>
</tr>
<tr>
<td>Keros type 3 (&gt;7 mm)</td>
<td>49</td>
<td>22.3</td>
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Tab. 1. The distribution of Keros type among the patients
Keros grades were type 2 (67.91%), type 3 (21.25%), and type 1 (10.83%) (Table 1, 2). We found asymmetry, i.e., a difference between the two sides ≥ 0.01 mm, in all patients, similar to the previous report of Alazzawi et al. (12) (Table 3).

Table 4 shows the distribution of CP, LLCP, MERP on the right and left sides.

### DISCUSSION

The paranasal sinuses exhibit complex anatomical variations with which ear, nose, and throat physicians must be familiar, as must endoscopic sinus surgeons to minimize complications. Thin-section CT optimally reveals anatomical details and also plays essential roles in the diagnosis and treatment of nasal and paranasal sinus disease (13). In particular, evaluation of the sphenoidal sinus is difficult, and the cellular anatomy of the ethmoid is complicated. Endoscopy and coronal and axial CT yield useful data (14). The development of functional endoscopic sinus surgery in the 80s and computed tomography and imaging techniques such as MR and CT have gained weight in the evaluation and so increased the accuracy of diagnosis and treatment of diseases of the paranasal sinuses (15).

The lamina cribrosa adjacent to bony structures in the lateral regions of the ethmoid roof are intrinsically weak, and can be easily damaged. The depth and anatomical variations of the ethmoid roof can be detected only in coronal sections. Therefore, all measurements were performed in the coronal plane with a slice thickness of 1 mm and all data were subjected to multiplanar reformatting.

In an earlier study performed in 450 patients with a Keros olfactory fossa, patients were divided into three groups in terms of the depth of the lateral wall of the cribriform layer. Type 1 had a depth of 1-3 mm (12% of patients). In the present study, patients with depths 1-3.99 mm were classified as type 1; those with depths 4-7 mm (70% of patients) as type 2; and those with depths ≥ 7 mm as type 3 (18% of patients). Overall, our figures were similar to those of earlier reports. Our data were derived from patients who either lived in or came for treatment to a city in an industrialized country, and we considered our patients to form a cross-section of the Turkish population.

Virgo et al. classified 58% of patients as Keros type 2, 28% as type 3, and 14% as type 1 (16). The figures reported by Souza et al. were 26.2% type 1, 73.3% type 2, and 0.5% type 3 (17). Our figures were 10.83% type 1, 67.91% type 2, and 21.25% type 3, which were similar to those reported in the literature.
FESS should be preceded by planning CT as intraoperative discovery of anatomical variations creates problems. To avoid morbidity, the anatomical relationships between vital structures must be known prior to surgery, and carefully considered as surgery proceeds.

Although there have been many studies on anatomical variations of the paranasal sinus, few have considered ethnic differences (Table 5). Further large-scale collaborative studies featuring endoscopic examination are required to improve our knowledge of anatomical variations and their distribution.

REFERENCES


sinuses. Preoperatively, it is essential to calculate the depth of the olfactory fossa.

Developments in CT and FESS have improved our understanding of anatomical variations of the paranasal region. The present results are novel, although some similarities with earlier data are apparent. The differences may reflect the relatively small number of patients in our study. However, we suggest that axial multiplanar reformating optimally reveals anatomical variations in the coronal and sagittal planes.

### Tab. V. Keros classification with literature

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<th>NUMBER</th>
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<th>TYPE 2</th>
<th>TYPE 3</th>
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