

Imaging of the Ethmomaxillary Sinus, its Prevalence, and Evaluation of its Relationship with Chronic Rhinosinusitis

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ABSTRACT

Objective: The presence of an ethmomaxillary sinus (EMS) may increase the susceptibility to inflammatory paranasal sinus diseases such as chronic rhinosinusitis (CRS) and cause difficulties in surgical interventions to the paranasal sinuses. Therefore, this study aimed to examine the EMS in patients with and without CRS.

Methods: The study included 150 patients (300 sides) diagnosed with CRS by the ear–nose–throat clinic and 151 individuals (302 sides) without CRS. Paranasal sinus computed tomography images were reviewed retrospectively. The presence of an EMS (bilateral or not) and its relationship with age and sex were examined. The severity of CRS was determined with the Lund–Mackay scoring system, and its relationship with EMS was evaluated.

Results: The EMS was detected in 7 patients (7/301, 2.32%) and 9 sides (9/602, 1.49%) of 301 patients (602 sides) included. The incidence in the CRS group was 2.6%. Three cases were unilateral, and one was bilateral. The incidence in the control group was 1.98%, two cases were unilateral, and one was bilateral. According to the Lund–Mackay scoring system, the mean CRS severity was 8.62 (± 5.47). Its severity was 5.25 (± 3.94) in the EMS group and 8.71 (± 5.48) in the non-EMS group.

Conclusion: No statistically significant difference was found between the groups with and without CRS in terms of the presence of EMS ($p = 0.723$). No evidence reveals that EMS increased the severity of CRS.

Keywords: Ethmoid Sinus, Maxillary Sinus, Paranasal Sinuses, Sinusitis, Tomography

INTRODUCTION

Ethmoidal cells exhibit a complex anatomy with numerous interconnected cavities. In some studies, these cells are classified into anterior and posterior groups, while in others, they are further subdivided into anterior, middle, and posterior segments [1, 2]. This region harbors specialized air cells that arise from variations in the location, neighboring structures, and

drainage patterns of ethmoidal cells. Notable examples of these specialized cells include Haller cells, Onodi cells, Agger nasi cells, retromaxillary cells (RMC), and the ethmomaxillary sinus (EMS). Understanding the detailed anatomy of the paranasal sinuses and these specific cell types is crucial for accurate disease characterization and surgical planning [3-7].

EMS is a variant paranasal sinus characterized by the presence of posterior ethmoid cells located in the upper part of the maxillary sinus (MS). It is adjacent to the posterior aspect of the MS and the orbital floor, with drainage into the superior meatus [7-10] (Figure 1). Retromaxillary pneumatization of posterior ethmoid air cells (RP.PEs) are air cells that occupy the same region as the EMS and are often mistaken for them. Several distinguishing features can be utilized to differentiate these two air cell types: EMS exhibits a prominent drainage duct, whereas RP.PEs do not. EMS is situated within the MS, while RP.PEs are located outside the MS wall. A maxillary septum separates EMS from the orbit, whereas an ethmoidal septum separates RP.PEs from the orbit [9].

It is believed that the presence of EMS affects the occurrence of chronic rhinosinusitis (CRS) and its treatment with functional endoscopic sinus surgery (FESS). Therefore, the detection of EMS before FESS is important. This is because highly pneumatized EMS can make it difficult to access the MS during FESS [7]. In addition, the anterior inferior wall of the EMS referred to as the ethmomaxillary plate (EMP), serves as the bony septum separating the EMS from the MS. If the EMP is identified before surgery and removed during FESS, a common drainage pathway is established for both the MS and EMS. As a result, the EMS is eliminated, preventing the persistence of potential inflammation within the EMS, and reducing the risk of recurrent CRS. Hence, surgeons should also consider the presence of variational structures during preoperative imaging [11].

Although the exact association between EMS and CRS remains unclear, it has been suggested that inadequate resection of ethmoid cells during FESS could contribute to CRS recurrence

Main Points;

- In this study, the relationship between the ethmomaxillary sinus and the presence and severity of chronic rhinosinusitis was aimed to be evaluated.
- It was determined that the frequency of ethmomaxillary sinus occurrence did not differ significantly between individuals with and without chronic rhinosinusitis. Furthermore, no significant difference in the severity of chronic rhinosinusitis was found between patients with and without ethmomaxillary sinus involvement.

[7]. Persistent anatomical structures and incompletely resected cells may also lead to the progression of mucosal thickening [12]. Therefore, investigating the presence of variational air cells in the context of CRS and their persistence after surgery is crucial. The objective of this study was to determine the prevalence of EMS, assess its association with CRS, and examine its impact on the severity of CRS.

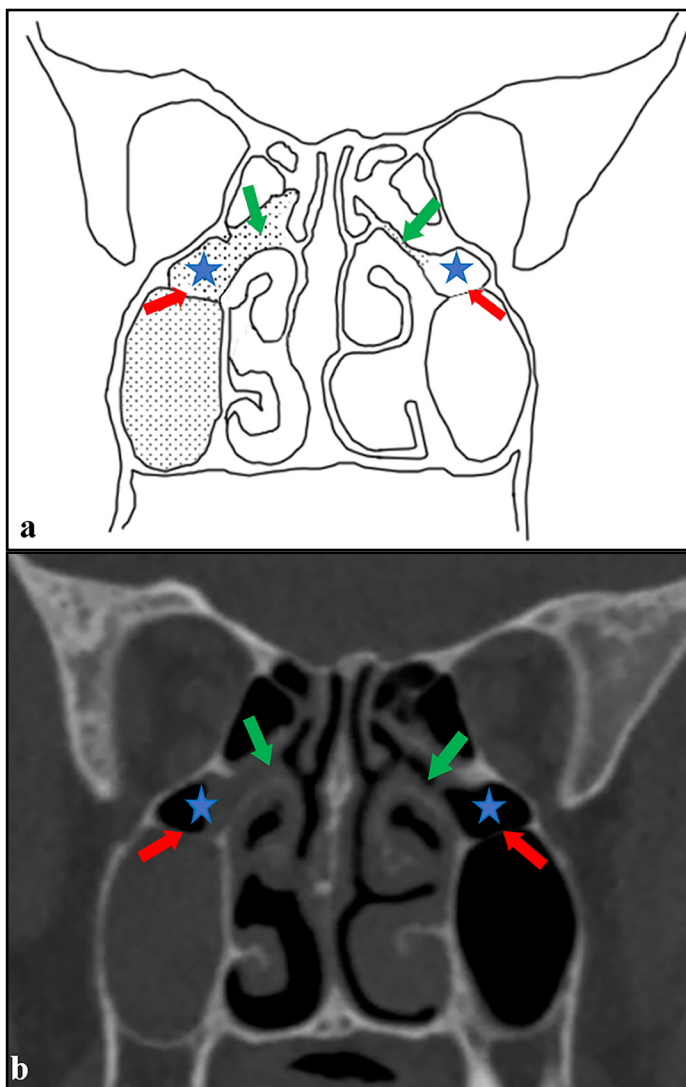


Figure 1. Bilateral EMS (Ethmomaxillary sinus) in a patient with chronic rhinosinusitis. There is inflammation in the left EMS that obstructs the ostium (schematic view **a**, paranasal sinus CT image **b**). Blue star, EMS; red arrow, ethmomaxillary plate; green arrow, opening of the EMS to the superior meatus

MATERIALS AND METHODS

Approval was obtained from the local ethics committee for the study. The research focused on the retrospective analysis of

paranasal sinus computed tomography (CT) images stored in the Picture Archiving and Communication Systems of Selcuk University Faculty of Medicine, Department of Radiology. The study conducted a power analysis to determine the most suitable sample size. According to the power analysis, the minimum sample size should have been 288, with 144 individuals in each group. Patients who visited the Ear, Nose, and Throat (ENT) clinic and underwent paranasal sinus CT imaging were screened. Sample selection was performed jointly by two ENT physicians. The patient group comprised 150 individuals with clinical diagnosis and imaging consistent with chronic rhinosinusitis, whereas the control group consisted of 151 individuals who had undergone CT imaging for reasons other than sinus-related issues, had normal paranasal sinus aeration, and lacked additional pathologies. Both groups were selected from individuals aged 18 or older without a history of paranasal sinus surgery or head trauma.

The images were acquired using a 256-slice CT device (Siemens Somatom Flash, Erlangen, Germany). The imaging parameters for the examinations were set as follows: kV at 100, matrix at 512×512 , collimation at 0.6×128 , rotation time at 1, and pitch value at 0.8. The obtained images had a section thickness of 1 mm and were assessed in the sagittal, coronal, and axial planes to investigate the presence of the EMS and the severity of CRS. The cases with EMS were identified based on the joint decision of a radiologist and an anatomist.

Based on the information extracted from patient files, the study examined the association between the EMS and the demographic characteristics of the patients, including age and sex. The prevalence of EMS was determined based on the analysis of the images, and the severity of sinusitis was assessed using the Lund-Mackay scoring system, which assigns a score out of 24 points, in patients diagnosed with CRS. It is important to note that for accurate scoring, all paranasal sinus structures and the osteomeatal complex should be present and evaluated in the computed tomography (CT) images. The study aimed to determine whether there was a correlation between the severity of sinusitis and the presence of EMS.

Statistical analyses were performed using the SPSS 22.0 Windows version software package. The Fisher's exact test was used for intergroup comparisons. A significance level of $p < 0.05$ was considered statistically significant.

RESULTS

The CRS group consisted of 150 patients, with 49 women (32.7%) and 101 men (67.3%). Among the patients in this group, three out of four individuals with EMS were female, while one was male. The control group comprised 151 patients, with 72 women (47.7%) and 79 men (52.3%). Within this group, two out of three patients with EMS were female, and one was male. The age range in the CRS group was 18 to 72 years, with a mean age of 42.49 (± 13.82) years. The average age of the four patients with EMS in this group was 43.5 years. In the control group, the age range was 18 to 73 years, with a mean age of 36.02 (± 14.15) years. The mean age of individuals with EMS in the control group was 21.3 years.

The EMS identification criteria established by Liu et al. [9] were employed to diagnose EMS. Among the 301 patients (602 sides) whose images were examined, EMS was detected in 7 cases, resulting in a prevalence of 2.32% (7/301). Out of these patients, five had unilateral EMS, and two had bilateral EMS, resulting in a total of nine affected sides (9/602, 1.49%). In the CRS group, the incidence of EMS was 2.6%. Among these patients, three had unilateral EMS, and one had bilateral EMS (Figure 1a, b). In the control group, the incidence was 1.98%, with two cases being unilateral (Figure 2a, b) and one being bilateral (Figure 2c, d). There was no significant difference in the incidence of EMS between the patient and control groups ($p = 0.723$). Since bilateral EMS was observed in only one patient in each group, intergroup analysis regarding bilaterality couldn't be performed. Significant difference in the frequency of EMS occurrence between male and female genders was not observed ($p = 0.122$).

The severity of CRS was determined using the Lund-Mackay scoring system [13], which evaluates severity on a scale of 24 points. The mean CRS severity score was 8.62 (± 5.47) in the overall patient population. Among patients with EMS, the mean severity score was 5.25 (± 3.94), while in patients without EMS, it was 8.71 (± 5.48).

Since the EMS is primarily associated with the MS and ethmoidal cells, a new scoring system was developed using select parameters evaluated in the Lund-Mackay scoring system. The scoring was conducted on a total of 12 points. Among patients with EMS, the average score was calculated as 3.75, while it was 4.74 for patients without EMS.

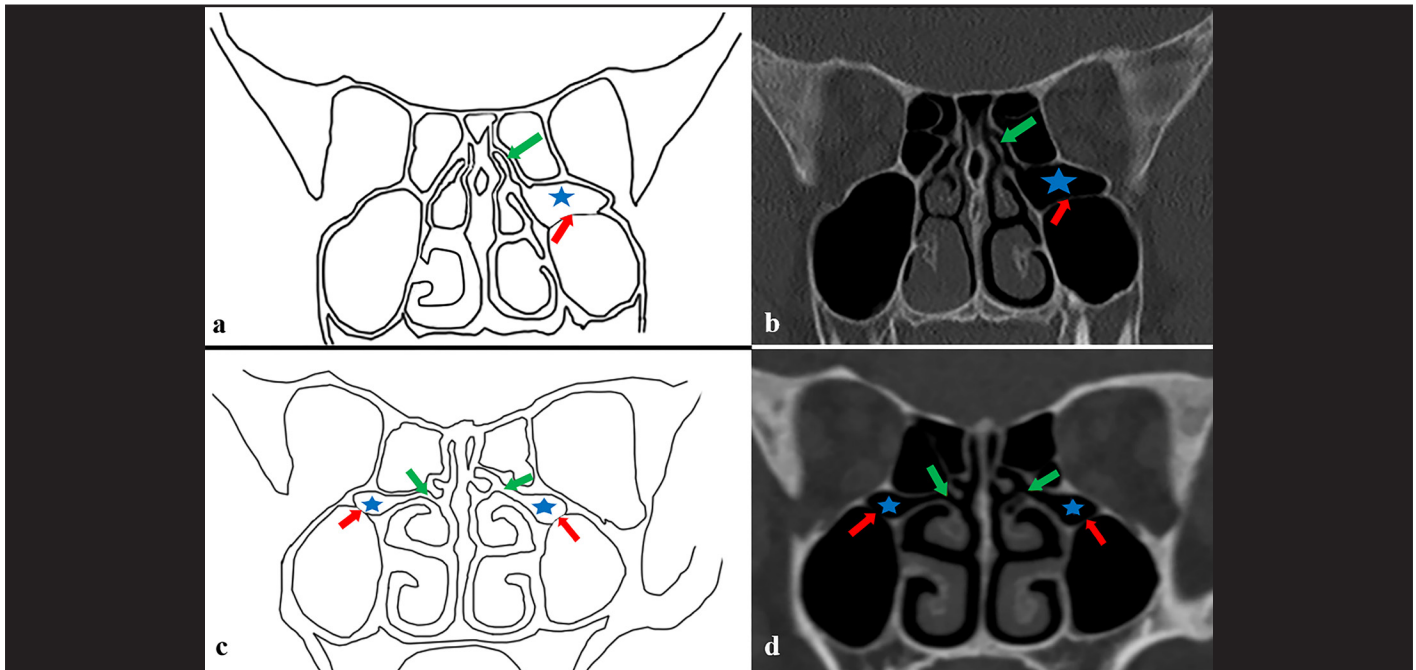


Figure 2. Left EMS (Ethmomaxillary sinus) in a patient without chronic rhinosinusitis (schematic view **a**, paranasal sinus CT image **b**). Bilateral EMS in a patient without chronic rhinosinusitis (schematic view **c**, paranasal sinus CT image **d**). Blue star, EMS; red arrow, ethmomaxillary plate; green arrow, opening of the EMS to the superior meatus

DISCUSSION

The definition of variational air cells, their relationship with each other, and diseases, is still being investigated, and their clinical effects have not been fully elucidated. Research on EMS has questioned its adjacency and association with other variational air cells. It has been reported that EMS is particularly associated with certain subtypes of cellular structures located in the posterosuperior part of the maxillary sinus and posterior ethmoid cells located in the retro-maxillary area [8, 14].

In the studies, topics such as the differentiation and characterization of the EMS from other air cells, its prevalence, degree of pneumatization, and its relationship with CRS have been discussed. This is motivated by the belief that identifying FESS can facilitate intervention and potentially reduce persistence when addressed [7, 9, 12].

In this study, a total of 9 EMS cases were identified, accounting for 1.49% of the 602 sides evaluated in 301 patients. Liu et al. reported a frequency of 7.1% [9], Zhou et al. reported 11.9% [7], Ozcan et al. reported 1.93% [15], and Sirikci et al. reported a frequency of 0.7% [10] for EMS occurrence. In a study conducted on the Russian population, the prevalence of EMS was found to be 2.4% [16]. The study conducted by Poojary et al. examined

the posterior ethmomaxillary cell. This cellular entity shares the same anatomical characteristics as EMS and was found to have a prevalence rate of 11.4% [11]. Kim et al.'s study reported a prevalence of EMS at 10.4%. This study concurrently evaluated the presence of EMS and Haller cells, providing insights into coexisting variations in cells [17]. This variation in prevalence may be due to the lack of a single, universally accepted definition of EMS, differences in the interpretation of images by researchers, or the ethnic origin of the studied groups. Accurate detection of air cells such as PEs, which are anatomically located in the same region and can be confused with EMS, is also important for the correct calculation of EMS prevalence.

Kim et al. investigated the relationship between EMS and CRS in their study. They did not find statistical significance in terms of CRS frequency between the side affected by EMS and the side without EMS [17]. Data from studies revealing the frequency of inflammatory paranasal sinus pathologies in patients with EMS were as follows: Liu et al. reported a frequency of 60.9% for CRS in individuals with EMS [9], Ozcan et al. found a mucosal inflammation frequency of 44.4% in patients with EMS [15], while Sirikci et al. indicated a frequency of 50% for maxillary sinusitis and 10% for ethmoidal sinusitis in individuals with EMS [10].

When looking at the mean values of the Lund-Mackay and modified Lund-Mackay scores, our study did not find evidence supporting the exacerbation of CRS by EMS. Zhou et al. conducted a classification of EMS into types I, II, and III based on their size. However, when they separately calculated the Lund-Mackay score for each type, they did not find a significant difference in terms of chronic rhinosinusitis (CRS) severity [7]. Conducting a preoperative and postoperative prospective evaluation in patients with CRS can better elucidate the impact of EMS on the presence, severity, and recurrence of CRS.

Limitations

The limitations of our study included not evaluating the frequency of other variational air cells, not assessing the relationship of EMS with paranasal sinus pathologies other than CRS (such as maxillary hypoplasia, concha bullosa), and having a small sample size.

CONCLUSIONS

In our study investigating the frequency of EMS occurrence in CRS individuals, we did not identify a relationship between EMS and CRS. Additionally, no evidence was found suggesting that EMS exacerbates CRS.

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Informed Consent: A formal informed consent procedure was waived due to the retrospective nature of this study.

Conflict of Interest: The authors declare that they have no conflict of interest.

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Ethical Approval: All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethical approval (approval number 2022/53) was given by the Non-Intervention Clinical Research Ethics Committee of the Medical Faculty.

Author Contributions: Design: Z,F; B,U- Project development: Z,F; B,U; M,T- Data collection and analysis: M,T; V,U; M,S,D- Review: Z,F; N,U,D; A,K,K- Writing: M,T; Z,F- Critical Review: Z,F; B,U.

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