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ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

Radiologic Evaluation of Paranasal Anomalies in the Presence of Accessory Maxillary Ostium In Pediatric Patients

Pediatrik Hastalarda Aksesuar Maksiller Ostium Varlığında Görülebilecek Paranazal Anomalilerin Radyolojik Olarak Değerlendirilmesi

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ABSTRACT

Aim: Accessory maxillary ostium may have an embryologic association with the variations around the paranasal sinuses. This study aimed to investigate the cross-sectional and developmental associations of the accessory maxillary ostium with various anatomical variations around the ostio-meatal complex and maxillary sinus in children.

Material and Method: Medical records and paranasal computed tomography sections of 457 patients aged 3–17 years were reviewed retrospectively. The study group consisted of 184 patients with accessory maxillary ostium (AMO group), and the control group consisted of 273 patients without accessory ostium. The frequencies of the anatomic variations around the ostio-meatal complex and maxillary sinus pathologies were compared between groups.

Results: Compared with the control group, the AMO group had a higher frequency of paradoxical middle turbinate (p=0.036, X2= 4.405), mucus retention cyst (p=0.007, X2= 7.179), Haller cell (p=0.003, X2= 8.875), and maxillary sinus septa (p=0.042, X2= 4.14).

Conclusion: Accessory maxillary ostium was significantly associated with the presence of paradoxical middle turbinate, mucus retention cyst, Haller cell, and maxillary sinus septa in children.

Keywords: Accessory ostium, maxillary sinus, ostio-meatal complex, paranasal sinus tomography, pediatric sinus

ÖZ

Amaç: Paranazal sinüslerin komşuluğundaki varyasyonlarla aksesuar maksiller ostiumu (AMO) arasındaki embriyolojik bir ilişki olabilir. Bu çalışmanın amacı çocuklarda aksesuar maksiller ostiumun, ostio-meatal kompleks ve maksiller sinüs komşuluğundaki çeşitli anatomik varyasyonlarla kesitsel ve gelişimsel ilişkilerini araştırmaktır.

Gereç ve Yöntem: Yaşları 3-17 arasında değişen 457 hastanın tıbbi kayıtları ve paranazal bilgisayarlı tomografi kesitleri retrospektif olarak incelendi. Çalışma grubunu aksesuar maksiller ostiumu olan 184 hasta (AMO grubu), kontrol grubunu ise aksesuar ostiumu olmayan 273 hasta oluşturdu. Ostio-meatal kompleks etrafındaki anatomik varyasyonların ve maksiller sinüs patolojilerinin sıklıkları gruplar arasında karşılaştırıldı.

Bulgular: Kontrol grubuyla karşılaştırıldığında AMO grubunda paradoksal orta konka (p=0.036, X2= 4.405), mukus retansiyon kisti (p=0.007, X2= 7.179), Haller hücresi (p=0.003, X2= 8.875) ve maksiller sinüs septası (p=0.042, X2= 4.14) sıklığı daha yüksek olarak tespit edildi.

Sonuç: Aksesuar maksiller ostiumu, pediatrik hastalarda paradokasal orta konka, mukus retansiyon kisti, Haller hücresi ve maksiller sinüs septasının varlığı ile anlamlı düzeyde ilişkili olarak bulundu.

Anahtar Kelimeler: Aksesuar ostium, maksiller sinüs, ostio-meatal kompleks, paranazal sinüs tomografisi, pediatrik sinüs

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INTRODUCTION

The maxillary sinus is a crucial component of the paranasal sinus system, with its anatomy and variations gaining increasing attention. The maxillary sinus natural ostium is located in the anterior fontanel with its oval form extending transversely and it is undetectable during nasal endoscopic examination since it is positioned deep in the infundibulum and out of sight because of the uncinate process (1). The accessory maxillary sinus ostium (AMO) is a an anatomical variation seen in the medial wall of the maxillary sinus as a second orifice frequently originating from the posterior fontanel, therefore if there is an ostium seen at middle meatus during a nasal endoscopic examination it is always an AMO (1,2).

AMO was reported in 10%–20% in the general population and approximately 30% in patients with chronic sinusitis (3,4). It is still not apparent whether an AMO is congenital or acquired. Some studies state that it may arise after acute maxillary sinusitis (5).

Maxillary sinus drainage occurs toward the natural ostium via the mucociliary transport. Anatomical and pathological alterations in the middle meatus or ostio-meatal complex (OMC) may lead to obstruction in this region causing sinus infections (6). In the presence of AMO, mucociliary clearance is impaired due to recycling of mucus between the natural and accessory ostia, resulting in chronic MS (5). Previous studies have reported that sinus infection caused by these anatomical variations might occur congenitally, and a higher pressure inside the sinus might result in the development of AMO as a perforation from the weak points at the level of the fontanel (6,7).

In this study, we aimed to investigate the cross-sectional and developmental associations of AMO with various anatomical variations around the OMC and the maxillary sinus in children.

MATERIAL AND METHOD

All procedures performed in this study were in accordance with the ethical standards of local ethical committee of Kartal Lutfi Kirdar Government Hospital (IRB Number: 2020- 514-170-3).

This retrospective, cross-sectional computed tomography (CT) study included 457 pediatric patients. The medical records and paranasal CT sections of 457 patients aged between 3–17 years were retrospectively evaluated. Patients with conditions such as nasal polyposis, fibrous dysplasia, Wegener granulomatosis, Paget disease, cystic fibrosis, history of surgery or trauma, presence of any paranasal neoplasia were excluded.

All paranasal CT scans were previously performed using a 128-slice CT unit (Ingenuity 128-DS; Koninlijke Philips N.V., Eindhoven, Netherlands) linked to an archiving and communication software (Infinitt, Phillisburg, NJ, USA) using an axial-plane bone window and reformatted images of the paranasal sinuses. The CT parameters were 100 kV, 0.67–2 mm slice thickness, 0.5s rotation time, and 0.4mm pitch. CT scans were conducted with patients lying in the supine position, aligning their head to position the hard palate parallel to the floor. For children, low-dose CT scans were performed using an 80 kV tube voltage with iterative reconstruction, and multiplanar thin-section images were acquired.

Patients were divided into two groups: AMO group comprising patients with an AMO at least on one side and the control group consisted of patients without AMO. Age, sex, sphenoid sinus type, and frequencies of various paranasal anomalies including nasal septum deviation, inter-sinus septum of the sphenoid sinus, paradoxical middle turbinate, mucosal thickening in the maxillary sinus, mucus retention cyst, concha bullosa, Onodi cell, Haller cell, Agger nasi cell, uncinate pneumatization, ethmoid bulla pneumatization, and maxillary sinus septa were compared between two groups.

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Statistical Analysis

Values are presented as numbers and percentages (%). The distribution pattern of age data of the groups were investigated using the Kolmogorov–Smirnov test ($p<0.001$). We compared the median age of the groups using Mann–Whitney U test. We used the Chi-square test to analyze the sex distribution and investigate the frequency of paranasal anomalies. All statistical analysis was performed using IBM SPSS Statistics for Windows, version 23 (IBM Corp., Armonk, NY, USA). A P value <0.05 was considered significant.

RESULTS

In total, 457 pediatric patients (male, n=204; female, n=253; mean age, 10.2 ±4.2 years; age range, 3–17 years) were found to be eligible for the study. The AMO group consisted of 184 patients [male, n=75; female, n=109; median age, 11 (3–17) years] and the control group consisted of 273 patients [male, n=129; female, n=144; median age, 10 (3–17) years]. The groups were matched by age (p=0.111) and gender (p=0.171, X2 =1.875).

Frequencies of paranasal anomalies of the control group and AMO group are presented in **Table 1**: The frequencies of nasal septum deviation (p=0.22, X2= 1.505), inter-sinus septum of the sphenoid sinus (p=0.1,

X2= 2.585), mucosal thickening in the maxillary sinus (p=0.147, X2= 2.1), concha bullosa (p=0.239, X2= 1.387), Agger nasi cell (p=0.075, X2= 3.164), uncinate pneumatization (p=0.762, X2= 0.092), and ethmoid bulla pneumatization (p=0.723, X2= 0.126) were not different between the control group and the AMO group. However, compared with the control group, the AMO group had a higher frequency of having paradoxical middle turbinate (p=0.036, X2= 4.405) (**Figure 1**), mucus retention cyst (p=0.007, X2= 7.179) (**Figure 2**), Haller cell (p=0.003, X2= 8.875) (**Figure 3**), and maxillary sinus septa (p=0.042, X2= 4.14) (**Figure 4**).

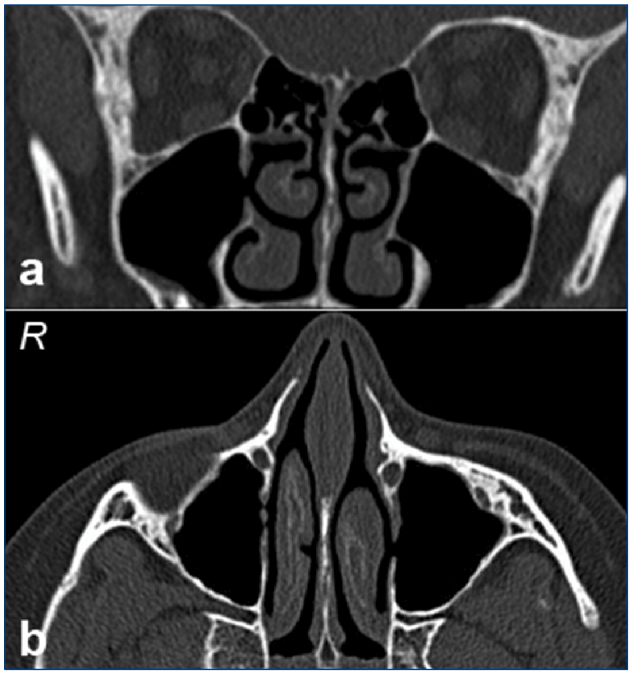

Figure 1. Paranasal CT sections of a 13-year-old boy with bilateral paradoxical middle turbinate and accessory maxillary ostium. a) coronal section b) axial section

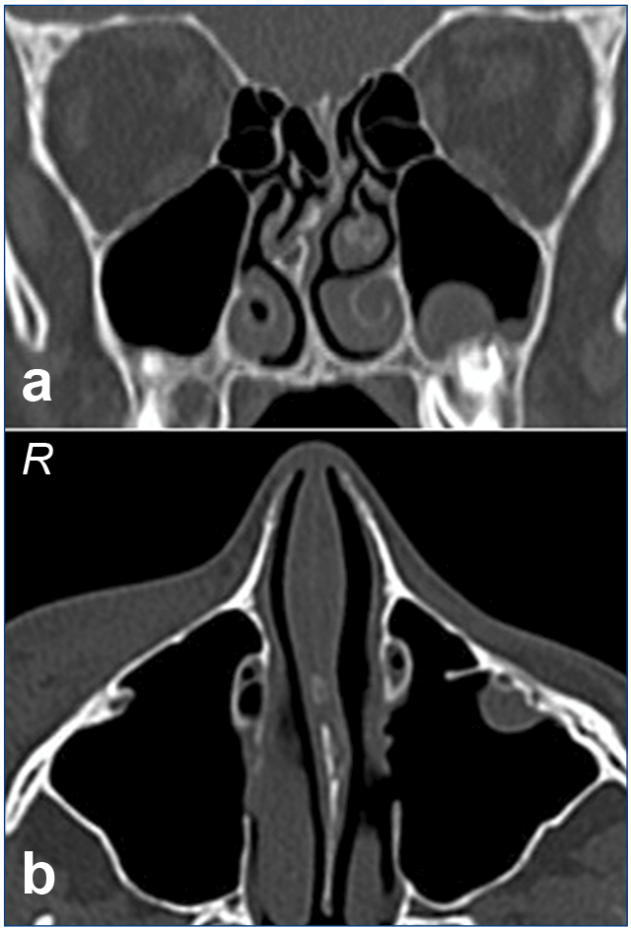

Figure 2. Paranasal CT sections of a 12-year-old girl with a mucus retention cyst and left accessory maxillary ostium. a) coronal section b) axial section

Table 1. Paranasal anomaly frequencies of the groups.

	Control group (n=273)	Accessory ostium group (n=184)	P value	X2 value
Nasal septum deviation	161 (59%)	119 (64.7%)	0.22	1.505
Inter-sinus septum of sfenoid sinus	123 (45%)	97 (52.7%)	0.1	2.585
Paradoxical middle turbinate	23 (8.42%)	27 (14.7%)	0.036	4.405
Mucosal thickening in maxillary sinus	65 (23.81%)	55 (29.9%)	0.147	2.1
Mucus retention cyst	9 (3.3%)	17 (9.24%)	0.007	7.179
Concha bullosa	148 (54.2%)	110 (59.78%)	0.239	1.387
Onodi cell	63 (23.08%)	49 (26.63%)	0.386	0.75
Haller cell	37 (13.55%)	45 (24.46%)	0.003	8.875
Agger nasi cell	182 (66.66%)	137 (74.4%)	0.075	3.164
Uncinate pneumatization	33 (12.08%)	24 (13.04%)	0.762	0.092
Ethmoid bulla pneumatization	17 (6.23%)	13 (7.06%)	0.723	0.126
Maxillary sinus septa	79 (28.94%)	70 (38.04%)	0.042	4.14

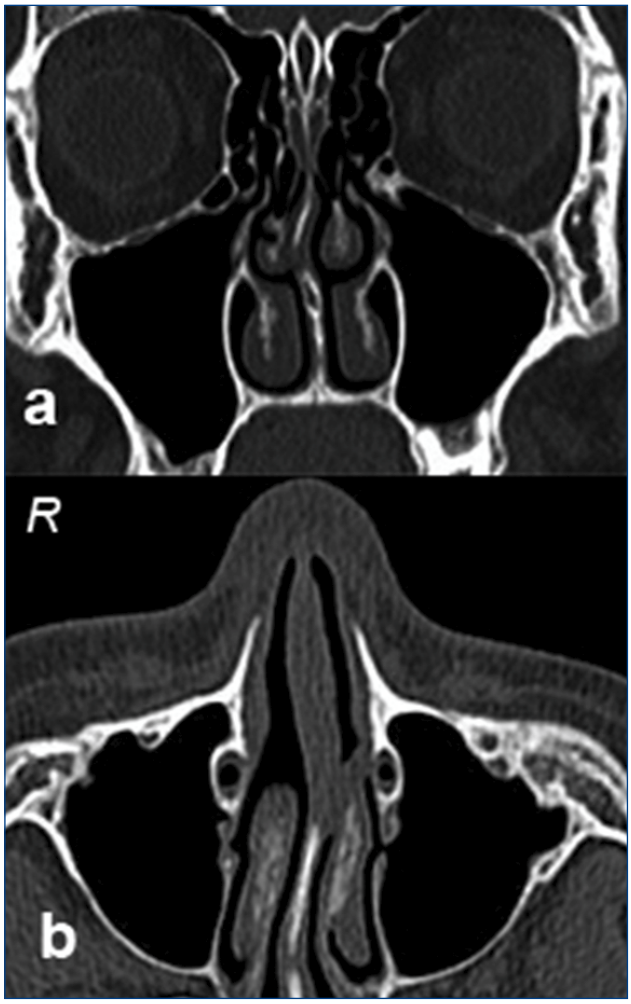

Figure 3. Paranasal CT sections of a 13-year-old boy with bilateral Haller cell and left accessory maxillary ostium. a) coronal section b) axial section

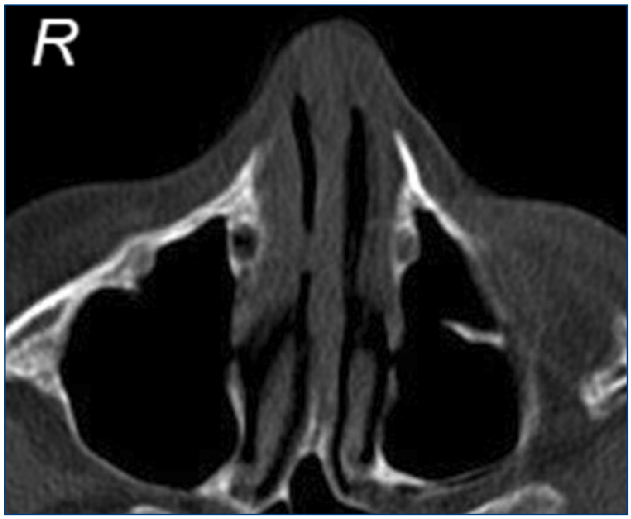

Figure 4. Axial paranasal CT sections of a 3-year-old boy with left maxillary sinus septa and bilateral accessory maxillary ostium

DISCUSSION

Sinonasal anatomical variations have increasingly been recognized as potential contributors to various sinonasal pathologies, driving the need for a comprehensive understanding of sinonasal anatomy. This is especially important in the realm of sinus surgeries, where an intimate knowledge of anatomy is key to minimizing complications and maximizing success rates. Several anatomic variations were reported to be associated with various pathologies in studies focusing on the accessory ostium (2,8,9). In this study we aimed to explore the relationship between accessory maxillary sinus ostium (AMO) and other sinonasal variations, with a specific focus on pediatric population.

Maxillary sinus development begins on days 60–70 of embryonic life as a lateral expansion from the nasal mucosa. The natural ostium of the maxillary sinus develops from this first expansion point and is in the anterior part of the posterior fontanel over the ethmoid infundibulum, as a component of the OMC (10,11). Pathologies or anatomic variations in this area may result in the development of sinusitis. In the presence of an accessory ostium, mucociliary transport is also going toward the natural ostium, but the recirculation from the accessory ostium may return the mucociliary transport to the sinus and cause infections, such as chronic maxillary sinusitis (12). Previously, the developmental process of an accessory ostium was considered congenital or acquired. Several studies have suggested that fontanels may have a congenital closure defect during the formation of the accessory ostium, or an ostium may originate from the fontanels because of recurrent infections (6,11,13). Genc et al. emphasized the effect of recurrent infections in the developmentof the accessory ostium using an experimental animal model of maxillary sinusitis (6).

Septal deviation may affect the nasal airway pressure, causing negative pressure, perforation, and accessory ostium development in the non-bony area of the fontanel. Ozel et al. reported a significant association between the accessory ostium and septal deviation depending on the side of the deviation (9). However, Yenigun et al. did not find a significant association between the accessory ostium and septal deviation (2). Similar to their study, we also did not find a significant association between the accessory ostium and septal deviation. Diversely, our study only enrolled children and we hypothesized that septal deviation might not have a sufficiently prolonged negative-pressure effect on the side or opposite side of the septal deviation in children.

The presence of Haller cell and accessory ostium was found to be associated with maxillary sinusitis (8). Several studies have also reported that Haller cell might cause recurrent sinus infection by occluding the maxillary sinus ostium (14,15). Despite not finding a direct association between Haller cell and sinusitis, Ali et al. reported a significant association between AMO and chronic sinusitis in the presence of Haller

cell. Consequently, both Haller cell and AMO might be associated with chronic sinusitis (8). However, Yenigun et al. did not find a significant association between the Haller cell and accessory ostium (2). In consistent with many of the previous studies, we found that the frequency of Haller cell was significantly higher in the AMO group than in the control group. However, further studies on larger age groups are needed to evaluate the age-related increase in the associations of Haller cell and confirm the causative mechanism of the development of accessory ostium related to the presence of Haller cell. In this context, our retrospective radiologic data cannot explain the causative mechanism of AMO development in patients with Haller cell, which might be a limitation of this study.

The presence of septa inside the maxillary sinus is an anatomic variation that could be observed on the inferior wall of the sinus. The presence of septa may result in an ineffective pneumatization of the sinus, leading to the development of sinusitis. Yildirim et al. showed that 27.2% of patients had at least one septum in the maxillary sinus (16). In our study, patients with AMO had a significantly higher frequency of maxillary sinus septa compared with patients without it (38.04% vs. 28.94%). However, this cross-sectional association cannot explain the causative mechanism of AMO development in patients with maxillary sinus septa. However, septa-associated pneumatization deficiency might result in the perforation on the fontanels.

Middle turbinate pathologies can affect the OMC and cause recurrent sinus infections (17). Yenigun et al. did not find an association between middle turbinate pneumatization and accessory ostium (2). Similarly, we did not find an association between the concha bullosa and the AMO. However, a significant association was noted between the paradoxical middle turbinate and AMO. Although this cross-sectional association could not reveal the mechanism of AMO development, the paradoxical middle turbinate might cause OMC contraction resulting in AMO development.

Retention cysts are usually located in the maxillary sinus, and occlusion of the ducts of the seromucous glands might trigger the development of retention cysts. A higher risk of chronic rhinosinusitis was reported in patients with retention cysts compared with those without them (18). On the contrary, Kanagalingam et al.reported that retention cysts could not be associated with sinusitis (19). In our study, the frequency of retention cyst was significantly higher in the AMO group than in the control group (9.24% vs. 3.3%), and our rates were comparable to the rates reported by Yenigun et al. (2). However, the incidence rates of mucosal thickening, uncinate pneumatization, and ethmoid bulla pneumatization were not different between the AMO group and the control group.

There were several limitations in this study. The decision to exclude patients with nasal polyposis due to sinus wall destruction may have impacted the ability to thoroughly assess the correlation between genuine chronic sinusitis and AMOs. Secondly, the clinical manifestations of AMOs were not evaluated since this was a radiological study. Morover, large patient cohorts are needed to verify the findings and offer satisfactory guidance for clinicians.

CONCLUSION

In light of the results obtained in our study, it can be concluded that: AMO was significantly associated with paradoxical middle turbinate, mucus retention cyst, Haller cell, and maxillary sinus septa in children. Paranasal CT evaluation might give detailed information about the anatomical variations of the OMC and the maxillary sinus so it must be done before performing any functional endoscopic sinus surgery.

ETHICAL DECLARATIONS

Ethics Committee Approval: All procedures performed in this study were in accordance with the ethical standards of local ethical committee of Kartal Lutfi Kirdar Government Hospital (IRB Number: 2020- 514-170-3).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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