



CLINICAL STUDY

INVESTIGATION OF THE RELATIONSHIP BETWEEN ANATOMICAL VARIATIONS OF SINONASAL REGION AND CHRONIC SINUSITIS IN CHILDREN

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SUMMARY

Introduction: To analyze the relationship between anatomic variations of the sino-nasal region and CS in children who underwent functional endoscopic sinus surgery (FESS).

Material and Methods: Computerized tomography(CT) scans of 68 children who underwent FESS between 2010 and 2018 were evaluated retrospectively. Patients were categorized into two groups according to age (group 1: aged 8-12 years; group 2: aged >12 years). Each CT scan was reviewed for the presence of agger nasi cells, Haller's cells, paradoxical middle turbinate, and nasal septum deviations of >3 mm. Involved sinuses were determined after observing opacification or mucosal thickening on CT.

Results: The maxillary sinus was the most commonly involved sinus. Agger nasi cells were the most common variation and were observed in 55 children (80.8%). Concha bullosa (CB) was the second most common variant, observed in 38 children (55.8%). There were 17 (25%) children with a nasal septum deviation of >3 mm. Paradoxical middle turbinates were noted in 18 (26.4%) and Haller's cells were observed in 13 (19.1%) children. There was no statistically significant difference between groups 1 and 2 for agger nasi cells, CB, paradoxical middle turbinate, or Haller's cells. There was a statistically significant difference between groups 1 and 2 for nasal septum deviation.

Conclusion: We found no significant differences between younger and older children in terms of anatomic variations of the sino-nasal region, apart from nasal septum deviation.

Keywords: Computerized tomography, Children, sinusitis, anatomical variations

ÇOCUKLARDA KRONİK SINÜZİT VE SINONAZAL BÖLGENİN ANATOMİK FARKLİLİĞİNİN İLİŞKİSİNİN ARAŞTIRILMASI

ÖZET

Giriş ve Amaç: Fonksiyonel endoskopik sinüs cerrahisi (FESS) uygulanan çocuklarda sinonazal bölgenin anatomik varyasyonları ile kronik sinüzit arasındaki ilişkiyi analiz etmek.

Gereç ve Yöntem: 2010 ve 2018 yılları arasında FESS uygulanan 68 çocuğun bilgisayarlı tomografi (BT) taramaları retrospektif olarak değerlendirildi. Hastalar yaşa göre iki gruba ayrıldı (grup 1: 8-12 yaş; grup 2: yaş > 12). Her BT taraması, agger nasi hücrelerinin, Haller'in hücrelerinin, paradoksal orta konka ve septum deviyasyonu > 3 mm'den fazla nazal septum sapmalarının varlığı açısından incelenmiştir. BT'de sinopasifikasyon veya mukozal kalınlaşma izlenen alanlar belirlendi.

Bulgular ve tartışma: Maksiller sinüs en sık tutulan gösteren sinüs olarak izlendi. 55 çocukta (%80.8) Agger nasi hücreleri en yaygın varyasyondur olarak gözlemlendi. Konka büllöz (KB), 38 çocukta (% 55.8) gözlenen en yaygın ikinci varyanttı. Nazal septum deviyasyonu > 3 mm olan 17 (% 25) çocuk izlendi. 18 (%26,4) çocukta Paradoksal orta konka, 13 (%19,1) çocukta Haller'in hücreleri gözlemlendi. Agger nasi hücreleri, KB, paradoksal orta konka veya Haller hücreleri için grup 1 ve 2 arasında istatistik olarak anlamlı bir fark yoktu. Nazal septum sapması açısından grup 1 ile 2 arasında istatistiksel olarak anlamlı bir fark izlendi.

Sonuç: Erken ve geç dönem çocuklar arasında sinonazal bölgenin anatomik varyasyonları, nazal septum deviyasyonu dışında anlamlı bir fark bulunamadı.

Anahtar Sözcükler: Bilgisayarlı Tomografi, Çocuklar, Sinüzit, Anatomik varyasyonlar

INTRODUCTION

Chronic sinusitis (CS) involves the persistence of symptoms, such as cough or purulent rhinorrhea attributable to the sinuses, for 3 months or more despite medical therapy.

It is caused by several factors, including infections, allergies, defects of immunity, and disorders of muco-ciliary transport. In addition, abnormalities of the middle turbinate, anterior ethmoid cells, septum, and other bony structures may impede the flow of secretions through the infundibulum, thereby leading to conditions conducive to the development of chronic sinus infection and inflammation¹.

Because of the narrow intranasal space and thin bony anatomy in children, the optic

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nerve, orbit, lacrimal drainage system, and cerebral tissues are at a greater risk of injury. Therefore, precise knowledge of anatomy and anatomic variations of the nose and paranasal sinus complex is essential for achieving optimal surgical results and avoiding complications.

Paranasal sinuses become apparent in the third and fourth fetal months and continue to expand after birth during the development of the facial cranium, ultimately reaching maturity around 12-years of age². These developmental changes may affect the frequency of anatomical variations in the sino-nasal region and the location of involved sinuses in children, making them different from those of adults.

Computerized tomography (CT) of the paranasal sinuses has become the modality of choice for the evaluation of patients who have failed medical therapy for CS and in whom surgery is contemplated³⁻⁶. With the increased use of CT, more attention has been paid to the anatomic variations of the bony nasal and sinus structures and the impact these variations may have on the etiology of CS. Past studies have examined the relationship between anatomical variations and CS in children^{3,5,7}. However, there is still controversy. Kim et al. found a higher incidence of anatomical abnormalities in the pediatric CS group than in the control group⁷. In contrast, Lusk et al. reported that sinusitis associated with anatomic variation does not occur as commonly as once believed⁸.

Therefore, the current study aimed to analyze the relationship between anatomic variations and CS in children who underwent functional endoscopic sinus surgery.

MATERIAL and METHODS

This retrospective study was conducted at the Department of Otolaryngology, Head and Neck Surgery from January 2010 to September 2018 after obtaining approval from the ethics committee (E18-2021).

Coronal CT scans of 68 children aged 8-18 years were evaluated. Patients with consistent symptoms, such as purulent nasal discharge, headaches, cough, and nasal congestion, even after maximal conservative management, including medical treatment, were

diagnosed as having CS. Patients were divided into two groups according to age (group 1 comprised children aged 8-12 years and group 2 included those aged >12 years).

The CT plane was direct coronal with 4 mm thickness and 3-mm increments (Ingenuity CT; Philips Healthcare, Andover, MA, USA). The kilovoltage setting was 125 with 75 mA intensity, and the scanning time was 12 s. The window width was 2000, with a center of 0. The view obtained from glabella to the posterior wall of the sphenoid sinus was achieved while the patient was in the prone position with his or her neck extended. Intravenous contrast was not used.

We excluded children who recently underwent surgery, had a previous sinus surgery, craniofacial anomalies, facial trauma, nasogastric tubes, or facial neoplasms. Children with a history of systemic disorders, syndromes, acute otitis media or tonsillitis, nasal stenosis, choanal atresia, immunodeficiency, cystic fibrosis, and those who were taking regular medications were also excluded from the study.

Each CT scan was reviewed for the presence of agger nasi cells, Haller's cells, paradoxical middle turbinate, and nasal septum deviations of >3 mm. Furthermore, sites of involved sinuses were determined after observing opacification or mucosal thickening on CT scan.

The study was conducted in accordance with the ethical principles stated in the Declaration of Helsinki. Prior to surgery, written informed consent was obtained from all the participants.

Statistical analyses were performed using SPSS 17. The results are expressed as medians, means, and standard deviation. Chi square, student's T-test, and Fischer's exact test were used for data analysis. P value of <0.05 was considered statistically significant.

RESULTS

In total, 68 children were included in the study. There were 38 males and 30 females, aged 8-18 (mean, 12.1-2.3) years. The maxillary sinus was the most commonly involved sinus, followed by the ethmoid, sphenoid, and frontal



sinuses, as shown in Table 1. Fourteen children (20.6 %) had only maxillary sinusitis. Thirty children (45%) had maxillary and anterior ethmoid sinusitis, 20 (30%) had maxillary and posterior ethmoid sinusitis, and 17 (25%) had anterior and posterior ethmoid sinusitis.

Agger nasi cells were the most common variation and were observed in 55 children (80.8%). Among these children, 87.2% had bilateral involvement. Concha bullosa (CB) was the second most common variant, observed in 38 children (55.8 %), and was typically seen on one side of the nasal wall. There were 17 (25 %)

children with a nasal septum deviation of >3 mm. Paradoxical middle turbinates were noted in 18 (26.4 %) and Haller's cells were observed in 13 (19.1%) children, as summarized in Table 2.

There was no statistically significant difference between groups 1 and 2 for agger nasi cells, CB, paradoxical middle turbinate, or Haller's cells. There was a statistically significant difference between groups 1 and 2 for nasal septum deviation.

Table 1. Anatomical variations of the sino-nasal region and chronic sinusitis

Opacification	Left	Right	Bilateral	Total
Maxillary	4	8	50	62 (80%)
Anterior ethmoid	6	9	26	41 (60%)
Posterior ethmoid	3	5	12	20 (30%)
Frontal	1	2	4	7 (10%)
Sphenoid	2	4	5	11 (15%)

Table 2. Anatomical variations of sinonasal region of 68 patients

	Group 1	Group 2	Total
Agger nasi	26	29	55 (80.8%)
Concha bullosa	20	18	38 (55.8%)
Paradoxical middle turbinate	8	10	18 (26.4%)
Haller's cell	6	7	13 (19.1%)
Septum deviation > 3mm	5	12	17 (25%)



Table 3. Incidence of anatomical variants in other studies

	April et al.	Willner et al.	Sivasli et al.	Kim et al.	Mohannad et al.	Present study
Agger nasi	(-)	20%	15%	69%	63%	80.8%
Concha bullosa	24%	16%	58%	32.7%	51%	55.8%
Paradoxical middle turbinate	13%	23%	4%	19.5%	28%	26.4%
Haller's cell	11%	35%	30%	34.5%	20%	19.1%
Septum deviation > 3mm	13%	13%	(-)	44.3%	18%	25%

DISCUSSION

Our results are consistent with those of Sivasli et al.⁹, April et al.³, and Kim et al.⁷ who reported that the maxillary sinus is the most commonly involved sinus in pediatric cases of CS. In contrast, the anterior ethmoid sinus is the most frequent site for CS in adults. There is greater involvement of the maxillary sinuses in children than in adults, probably because of the smaller dimensions of the middle meatus in children¹⁰.

Paranasal sinus development starts during the third and fourth fetal months as evaginations of the nasal mucosa and occurs in successive stages with rapid growth during specific ages⁸. Langford et al.¹¹ studied maxillary sinus development and observed an accelerated growth rate between 5 and 11 years of age, corresponding to the development and eruption of permanent dentition. Vinter et al.¹² studied ethmoid bone development and its relationship with the frontal bone and found that the ethmoid bone underwent excessive pneumatization at 9 years of age.

Agger nasi cells are the anterior ethmoid cells located in the anterior superior portion of the middle turbinate. When these cells are sufficiently pneumatized, they may extend to the frontal sinus entrance, block the frontal recess, and cause frontal sinusitis. Other researchers have reported agger nasi cells in up to 98.5% of adults¹³. We observed agger nasi cells in 80.8% of our study cohort; however, the average age of our patients was 12.1 years. One possible explanation of this difference could be that agger

nasi cells continue to develop even after the completion of ethmoid sinus development owing to frontal sinus expansion.

Pneumatization of the middle turbinate is referred to as CB. Depending on the degree of pneumatization, CB can be classified into three types: (1) lamellar type: pneumatization of the vertical lamella of the concha, (2) bulbous type: pneumatization of the bulbous segment, and (3) extensive type: pneumatization of both the lamellar and bulbous parts¹⁴. The degree of pneumatization is correlated with symptom severity. Lamellar type CB usually does not manifest any symptoms; however, the bulbous and extensive types may alter normal airflow and mucous drainage pathways, potentially causing edema in the middle meatus. These events can lead to maxillary or ethmoid sinusitis¹⁴, and often require surgical correction. Further studies with additional patients are needed to assess the frequency of these subtypes and their role in pediatric CS.

In children, nasal septum deviation has a reported prevalence of 46%⁷. This prevalence also increases with age, as reported by Van der Veken et al.¹⁵ and Kim et al.⁷. Possible causes of nasal septum deviation in children include trauma, developmental defects, finger sucking, and mouth breathing¹⁴. We observed more instances of nasal septum deviation in group 2 than in group 1. This may be attributable to the growth characteristics of the septal cartilage, nasal bones, and midface. This growth generally continues until the age of 18 years.



Caughey et al.¹⁶ showed that the size, rather than the presence of infraorbital cells, predisposes individuals to maxillary sinusitis. This should be considered while planning surgical therapy.

Limitations of our study as follows; selection and CT scan bias, as well as genetic and environmental factors likely influenced our results and additional studies with larger cohort are needed.

In conclusion, published literature details several anatomic variations of the sinonasal region, and our study is an addition to this corpus. We found no significant differences between younger and older children in terms of anatomic variations of the sinonasal region, apart from nasal septum deviation.

REFERENCES

1. Pochon N, Lacroix J-S. Incidence and surgery of concha bullosa in chronic rhinosinusitis. *Rhinology*. 1994;32(1):11-4.
2. Anderhuber W, Weiglein A, Wolf G. Nasal cavities and paranasal sinuses in newborns and children. *Acta anatomica*. 1992;144(2):120-6.
3. April MM, Zinreich SJ, Baroody FM, Naclerio RM. Coronal CT scan abnormalities in children with chronic sinusitis. *The Laryngoscope*. 1993;103(9):985-90.
4. Wald ER. Chronic sinusitis in children. *The Journal of pediatrics*. 1995;127(3):339-47.
5. Lusk RP, McAlister B. Anatomic variation in pediatric chronic sinusitis: a CT study. *Otolaryngologic Clinics of North America*. 1996;29(1):75-91.
6. Milczuk HA, Dalley RW, Wessbacher FW, Richardson MA. Nasal and paranasal sinus anomalies in children with chronic sinusitis. *The Laryngoscope*. 1993;103(3):247-52.
7. Jun Kim H, Jung Cho M, Lee J-W, Tae Kim Y, Kahng H, Sung Kim H, et al. The relationship between anatomic variations of paranasal sinuses and chronic sinusitis in children. *Acta oto-laryngologica*. 2006;126(10):1067-72.
8. Shah RK, Dhingra JK, Carter BL, Rebeiz EE. Paranasal sinus development: a radiographic study. *The Laryngoscope*. 2003;113(2):205-9.
9. Sivaslı E, Şirikçi A, Bayazıt Y, Gümüşburun E, Erbagcı H, Bayram M, et al. Anatomic variations of the paranasal sinus area in pediatric patients with chronic sinusitis. *Surgical and Radiologic Anatomy*. 2002;24(6):399-404.
10. Zinreich S, Kennedy DW, Rosenbaum AE, Gayler B, Kumar A, Stammberger H. Paranasal sinuses: CT imaging requirements for endoscopic surgery. *Radiology*. 1987;163(3):769-75.
11. Langford RJ, Sgouros S, Natarajan K, Nishikawa H, Dover MS, Hockley AD. Maxillary volume growth in childhood. *Plastic and reconstructive surgery*. 2003;111(5):1591-7.
12. Vinter I, Krmpotic-Nemanic J, Hat J, Jalsovec D. The frontal sinus and the ethmoidal labyrinth. *Surgical and Radiologic Anatomy*. 1997;19(5):295-8.
13. Bolger WE, Parsons DS, Butzin CA. Paranasal sinus bony anatomic variations and mucosal abnormalities: CT analysis for endoscopic sinus surgery. *The Laryngoscope*. 1991;101(1):56-64.
14. Aktas D, Kalcioğlu MT, Kutlu R, Özturan O, Oncel S. The relationship between the concha bullosa, nasal septal deviation and sinusitis. *Rhinology*. 2003;41(2):103-6.
15. Clement P, Buisseret T, Desprechins B, Kaufman L, Derde M. CT-scan study of the incidence of sinus involvement and nasal anatomic variations in 196 children. *Rhinology*. 1990;28(3):177-84.
16. Caughey RJ, Jameson MJ, Gross CW, Han JK. Anatomic risk factors for sinus disease: fact or fiction? *American journal of rhinology*. 2005;19(4):334-9.