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ORIGINAL ARTICLE

The incidence of anatomic variations and sinus opacities in pediatric patients with chronic sinonasal symptoms

Kronik sinonazal semptomları olan pediatrik hastalarda anatomik varyasyon ve sinüs opasiteleri insidansı

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Objectives: In this study our purpose was to determine the incidence of paranasal sinus anatomic variations and their relationship with sinus opacities in pediatric patients.

Patients and Methods: A total of 44 children ranged between 3 and 16 years of age unresponsive to maximum medical therapy were evaluated with coronal paranasal sinus computed tomography.

Results: Computed tomographic evaluations revealed that 70.5% (31/44) of the patients had at least 1 anatomic variation; the most common one was septal deviation, followed by concha bullosa and agger nasi cells. Sinus opacities were found in 81.8% (36/44) of the patients, of whom 9 had single and 27 had multiple involvement of sinus groups. Most common involved sinuses were anterior ethmoids and maxillary sinuses, followed by posterior ethmoids, sphenoid and frontal sinuses. When we look at the influence of anatomic variations on sinus opacities; patients with single, multiple and no anatomic variations had 78.9% (15/19), 83.3% (10/12), and 84.6% (11/13) opacities, respectively.

Conclusion: Incidence of anatomic variations was found to be similar to that reported for adults in the literature; except nasal septal deformity which was found lower than adults. Our results revealed no correlation between bony anatomic variations and sinus opacities in children.

Key Words: Child; nasal cavity/pathology/radiography; nasal septum/abnormalities; paranasal sinus diseases/radiography; sinusitis/radiography; tomography, X-ray computed/methods; turbinates/abnormalities/radiography.

Amaç: Bu çalışmada, çocuk hastalarda paranazal sinüs anatomik varyasyonlarının insidansı ve sinüs opasiteleri ile ilişkilerinin belirlenmesi amaçlandı.

Hastalar ve Yöntemler: Maksimum tıbbi tedaviye yanıt vermeyen, yaşları üç ile 16 arasında değişen 44 çocuğun koronal paranazal sinüs tomografisi değerlendirildi.

Sonuç: Değerlendirme sonucunda hastaların %70.5'inde (31/44) en az bir anatomik varyasyon belirlendi. En sık izlenen anatomik varyasyon septum deviasyonu oldu, bunu konka bulloza ve agger nazi hücreleri takip etti. Hastaların %81.8'inde (36/44) sinüs opasitesi belirlendi. Sinüs opasitesinin, dokuz hastada tek bir sinüste, 27 hastada ise multipl olduğu izlendi. Sinüs opasitesinin en sık ön etmoidler ve maksiller sinüste olduğu, bunu arka etmoidler, sfenoid ve frontal sinüslerin takip ettiği görüldü. Sinüs opasitelerine anatomik varyasyonların etkileri değerlendirildiğinde; tek bir anatomik varyasyonu olan hastaların %78.9'unda (15/19), multipl anatomik varyasyonu olanların %83.3'ünde (10/12) ve anatomik varyasyonu olmayanların %84.6'sında (11/13) sinüs opasitesi belirlendi.

Tartışma: Septum deviasyonu dışındaki anatomik varyasyonların insidansının erişkinlerdekine benzer olduğu, septum deviasyonu insidansının ise erişkinlere göre daha düşük olduğu belirlendi. Ayrıca, anatomik varyasyonlarla sinüs opasiteleri arasında belirgin bir ilişki bulunamadı.

Anahtar Sözcükler: Çocuk; nazal kavite/patoloji/radyografi; nazal septum/anomaliler; paranazal sinüs hastalıkları/radyografi; sinüzit/radyografi; tomografi, x-ışını, kompüterize/metodlar; konkalar/anomaliler/radyografi.

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Management of recurrent or chronic sinusitis is still a difficult problem in childhood period, especially in those resistant to medical therapy. In recent years many authors are in favor of surgical intervention in children who failed maximum medical therapy. Formerly, a ventilation procedure for maxillary sinuses such as antral lavage or nasal antral window possibly in combination with an adenoidectomy was the maximal surgical treatment. Today endoscopic sinus surgery (ESS), especially minimally invasive ESS, has gained acceptance in the pediatric population but with meticulous selection of candidates in order to avoid excessive surgery. In the evaluation of pediatric patients, nasal endoscopy is difficult to perform. Coronal computed tomographic (CT) investigation is considered superior to plain radiographies in evaluating sinus disease. Therefore CT examination is used to confirm clinical suspicion, which can display areas of residual disease and anatomic abnormalities. If surgical intervention is planned, the surgeon needs to appreciate detailed anatomy to completely eradicate the disease and avoid complications.

Developmental anomalies in children can present difficulties to the surgeon. Hypoplasia of the maxillary sinuses or anatomic variations of the ostiomeatal unit should be kept in mind during surgery. Concha bullosa, Haller's cells, and paradoxic middle turbinate are considered to narrow conduits of mucociliary clearence at the ostiomeatal complex and predispose patients to chronic rhinosinusitis.[1] Thus, knowledge of anatomic variation incidence and associated surgical findings will better prepare the endoscopic sinus surgeon.

The purpose of this study was to detect the incidence of CT abnormalities such as anatomic variations and opacities in a group of pediatric patients with chronic sinonasal symptoms unresponsive to medical therapy.

MATERIALS AND METHODS

Pediatric patients with chronic or recurrent sinonasal symptoms and signs such as nasal obstruction, purulant rhinorhea, postnasal drainage, and halithosis comprised the population of the study. Such patients were tried at least two courses of 2 weeks antibiotic therapy, and those unresponsive were included in the study. A total of 44 children underwent CT scanning of the paranasal sinuses between April 2000 and November 2001. A Hitachi Radix Turbo spiral CT machine (100 mA and 120 kV, with high resolution) was used. Coronal CT scans of 3 mm sections were taken without using contrast material.

Evaluation of CT scans was performed by two otorhinolaryngologists. Bony anatomic variations and sinus opacities were recorded for each patient. The incidence and sites of anatomic variations such as concha bullosa, Haller' cells, paradoxical middle turbinate, agger nasi cells, prominent ethmoid bulla and septal deformity was determined. Further analysis was applied with respect to age distribution of anatomic variations as well as their relevance to sinus opacities. The relation of anatomic variations and sinus opacities with respect to age was evaluated in 2 groups of patients; 3-7 years versus 8-16 years.

Anterior rhinoscopic examination was done and mild septal deviations were ignored. Any degree of pneumatization in the middle concha was acceppted as concha bullosa.

Statistical analyses were done with chi-square test.

RESULTS

Fourty four patients were included in the study and their ages ranged between 3 and 16 years with a median of 8. Of the 44 patients 54.5% (24/44) were female and 45.5% (20/44) male. Physical examination revealed adenoid vegetation in 79.5% (35/44) of the patients. Sinus opacities were found in 81.8% (36/44) of the patients and these were diagnosed as sinusitis. The patients with and without adenoid vegetation had sinus opacities as 48% vs 28%, and there was no significant correlation between adenoid vegetation and sinusitis ($p>0.05$). Those with adenoid vegetation had variable degrees of upper airway obstruction. All patients with adenoid vegetation underwent adenoidectomy.

CT evaluations revealed that 70.5% (31/44) of the patients had at least 1 anatomic variation; whereas 29.5% (13/44) lacked any. Nineteen and 12 patients had 1 and more than 1 anatomic variations, respectively. The most common was septal deviation 40.9% (18/44), followed by concha bullosa 29.5% (13/44) and agger nasi cells 25% (11/44). Concha bullosa was bilateral in 9 patients. Paradoxical middle turbinate and Haller's cell was found in 6.8% (3/44)

and in %2.3 (1/44) of the patients, respectively (Table I).

Sinus opacities were found in 81.8% (36/44) of the patients, of whom %25 (9/36) had single and %75 (27/36) had multiple involvement of sinus groups. Most commonly involved sinuses were anterior ethmoids 70.5% (31/44) and maxillary sinuses 61.4% (27/44), followed by posterior ethmoids 54.5% (24/44), sphenoid 29.5% (13/44) and frontal 6.8% (3/44) sinuses (Table II). When we look at the relation of anatomic variations and sinus opacities; patients with single, multiple and no anatomic variations had 78.9% (15/19), 83.3% (10/12), and 84.6% (11/13) sinus opacities, respectively (Table III).

The incidence of anatomic variations and sinus opacities with respect to age was evaluated in 2 groups of patients; 3-7 years versus 8-16 years. There were 21 and 23 patients in the first and second groups. In the first group anatomic variations were determined in 57.1% (12/21); and septal deviation [38.1% (8/21)] was the most common followed by concha bullosa [23.8% (5/21)], paradoxical concha [14.3% (3/21)], agger nasi [9.5% (2/21)], Haller cell [4.8% (1/21)] (Table I). In the same group 95.2% (20/21) had opacities of sinuses distributed as anterior ethmoids [81% (17/21)], posterior ethmoids [76.2% (16/21)], maxillary sinuses [76.2% (16/21)], sphenoid [38.1% (8/21)] and frontal [4.8% (1/21)] sinuses (Table II). In the group with older patients 82.6% (19/23) had anatomic variations as follows; septal deviation [43.5% (10/23)], agger nasi [39.1% (9/23)], and concha bullosa [34.8% (8/23)] (Table I). Sixtynine percent (16/23) of these patients had sinus opacities in the following order; anterior ethmoids [60.9% (14/23)], maxillary [47.8% (11/23)], posterior ethmoids [34.8% (8/23)], sfenoid [21.7% (5/23)] and frontal [8.7% (2/23)] sinuses (Table II).

DISCUSSION

Diagnosis and management of chronic sinusitis have evolved tremendously in the last two decades. This can be attributed to the technic of ESS as well as utilization of high resolution CT in the evaluation of diseases. So far accrued data from the cadaver dis-

TABLE I

THE INCIDENCE OF ANATOMIC VARIATIONS IN PEDIATRIC PATIENTS

Anatomic variations	n=44	%	n_{G1}=21	%	n_{G2}=23	%
Septal deviation	18	40.9	8	38.1	10	43.5
Concha bullosa	13	29.5	5	23.8	8	34.8
Agger nasi	11	25	2	9.5	9	39.1
Paradoxical middle turbinate	3	6.8	3	14.3	0	0
Haller's cell	1	2.3	1	4.8	0	0
Total	31	70.5	12	57.1	19	82.6

Overall, group 1(G1) (younger than age 8) and group 2 (G2) (older than age 8).

TABLE II

SINUS OPACITY OF THE PATIENTS

Opacity found	n=44	%	n_{G1}=21	%	n_{G2}=23	%
Anterior ethmoid	31	70.5	17	81	14	60.9
Posterior ethmoid	24	54.5	16	76.2	8	34.8
Maxillary sinus	27	61.4	16	76.2	11	47.8
Frontal	3	6.8	1	4.8	2	8.7
Sphenoid sinus	13	29.5	8	38.1	5	21.7
Total	36	81.8	20	95.2	16	69.6

n: number of patients, n_{G1}: number of group 1 patients (younger than age 8), n_{G2}: number of group 2 patients (older than age 8).

TABLE III
THE RELATIONSHIP OF ANATOMIC VARIATIONS AND SINUS OPACITIES

Number of anatomic variations	Anatomic variations n_{AV}=44	%	Opacity n_O=36	n_O/n_{AV} %
None	13	29.5	11	84.6
One	19	43.2	15	78.9
More then one	12	27.3	10	83.3

n_{AV}: number of patients with anatomic variations, n_O: number of patients with sinus opacity.

sections and CT studies of paranasal sinuses have clarified the anatomic details of sinuses along with variations from normal. Familiarity with these variations is important clinically and also during surgery to avoid any risk. Anatomic variations in paranasal sinus structures may predispose patients to recurrent or chronic sinusitis and in some cases to headaches. Stammberger and Wolf[2] cited variations of paranasal sinus structures as possible etiologic factors in sinus diseases and headache. Kennedy,[3] also mentioned the role of anatomic variations in the multifactorial etiology of sinusitis.

In children the situation is similar and appreciating the anatomic variations facilitates the clinical management. Most of them do not need to be operated unless they are clearly symptomatic. In our study we could not find any correlation between anatomic variations and occurrence of sinusitis in children. In a study aimed to determine the prevalence in pediatric patients (3 to 16 years) presenting with chronic cough, they found sinus abnormalities in 66.6% of the CT scans. The most common anatomical abnormalities were concha bullosa, paradoxical middle turbinate, Haller's cell, and deviated nasal septum but without any correlation to sinonasal diseases. They recommended imaging studies of the sinuses in children with chronic cough.[4] Diagnostic nasal endoscopy without general anesthesia is rather difficult in children. Computed tomography is more rational in the evaluation of these patients, particularly spiral method takes the images only in several seconds. Coronal CT displays the normal anatomical relationships and variations, as well as sinus diseases. Aprill and Zeinrich have proposed coronal CT as the optimal study in children with chronic or recurrent sinusitis. They determined a significantly greater frequency of disease compared to adult studies, in maxillary, anterior-posterior ethmoids, and frontal sinuses.[5] Our data was also parallel to this report, in which we found that anterior/posterior ethmoids and maxillar sinuses were mostly involved irrespective of the age group. Despite its superior performance, CT should not be used exclusively to diagnose diseases or propose surgery in this age group. These determinations must be made on the basis of a combination of the patient's symptoms, physical examination findings, and CT results.[6]

In review of the literature we found the incidence of bony anatomic variations of our study group was similar to that reported in adults. However, incidence of septal deformity was found relatively lower than the adults. Kennedy and Zinreich[7] reported a study in adults with an incidence of concha bullosa in 36%, septal deformity in 21%, paradoxical middle turbinate in 15%, Haller's cell in 10% and a large ethmoid bulla in 8%. In another study of adult patients with chronic sinusitis, concha bullosa was present in 17%, Haller's cell in 46% and paradoxical middle turbinates in 27%.[8] Calhoun et al.[9] reported concha bullosa in 29%, septal deformity in 40% and paradoxical middle turbinates in 12% of adult patients with chronic sinusitis. The earliest study we found in the literature that has attempted to identify the paranasal sinus anatomic variations in children, was conducted by van der Veken.[10] In that study 196 children suspected of having rhinosinusitis, without looking for treatment failures, were rewieved. Anatomic variations were determined as concha bullosa in 8%, Haller's cell in 3% and septal deformity in 46% of the patients. Another study by April MM et al.,[5] reported incidence of paranasal sinus anatomic variations in children with chronic sinusitis who were unresponsive to medical therapy. They determined concha bullosa in 19%, Haller's cell in 18%, septal deformity in 13%, paradoxical middle turbinate in 7%, and prominant ethmoidal bulla in 2% of the patients. Başak et al.[11] reported concha

bullosa in 28%, septal deviation in 23%, over pneumatized ethmoidal bulla in 17%, Haller's cell in 14%, paradoxical middle turbinate in 9% and uncinate process variations in 9% of the patients.

Our data was also parallel to previous studies but we found a relatively higher incidence of concha bullosa (30%) and paradoxical middle turbinate (14%). The anatomic variations were determined more in the older group compared to the younger (82.6% vs 57.1%); particularly septal deviation (43.5% vs 38.5%), concha bullosa (%34.8 vs %23.8), and agger nasi cells (%39.1 vs %9.5). These can be attributed to development and aeration process of sinuses during the growth period.

Looking at the relationship between anatomic variations and sinus opacities we found no correlation. Eightyfour percent and 80.6% of the patients without and with anatomic variations had sinus opacities. We further analysed the role of multiple anatomic variations versus single with respect to incidence of sinus diseases. However, we found that 84.6%, 78.9%, and 83.3% of the patients with no, single, and multiple variations had sinus disease. Our results, as in previous reports, suggest that anatomic variations are not the single etiological factor in the pathogenesis of sinusitis. Opacities were determined more in the younger group (%95.2 vs %69.6) especially in the anterior ethmoids (%81 vs %60.9), posterior ethmoids (%76.2 vs %34.8), and maxillary sinus (%76.2 vs %47.8). This may suggest that younger children with chronic sinonasal symptoms have higher probability of involvement of sinuses than the older ones.

Treatment of chronic sinusitis in children unresponsive to maximum medical therapy is still being discussed. Direct treatment of maxillary sinus disease versus adenoidectomy alone is evolving towards a target-oriented approach to the anterior ethmoid and ostiomeatal complex problems. In a prospective non-randomized study of pediatric patients with CT documented sinusitis, Ramadan[12] determined that ESS (77%) was better than adenoidectomy (47%) in terms of clinical improvement. More conservative surgical techniques are suggested in endoscopic sinus surgery. Especially in children it is mandatory to perform a surgical therapy that will cause minimal tissue damage in order to preserve growing patterns of the child. This approach is called "minimally invasive sinus surgery" which is directed only to the structures thought to play role in the pathogenesis of infection. In a recent study of 8 pediatric patients treated with unilateral sinus surgery for periorbital or orbital cellulitis, the long-term (average 6.9 years) impact of sinus surgery on paranasal sinus development was found to be only minimal changes in facial volume measurements, confirming clinical impressions that sinus surgery in children is safe and without significant cosmetic sequelae.[13]

In this study we found the incidence of paranasal sinus anatomic variations (70.5%) in pediatric patients similar to that of adults reported in the literature. Our results revealed no correlation between bony anatomic variations and sinusitis in children. We consider that the role of bony anatomic variations and mucosal abnormalities noted on coronal sinus CT scans must be evaluated for each patient with respect to history and clinical examination. Paranasal sinus CT examination should only be considered in patients refractory to multiple attempts of medical therapy, and those candidates for surgery.

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