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The incidence of pneumatized inferior turbinate and relation to close anatomic structures

Running head: Pneumatized inferior turbinate

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ABSTRACT

Background: The pneumatization of the inferior turbinate (PIT) is a rare abnormality of the paranasal sinus. It is very difficult to differentiate from the hypertrophia of the inferior turbinate clinically. Thus, it is important to be thought in especially cases with no response to medical treatments. We aimed to investigate the presence and the frequency of PIT by computerized tomography (CT).

Materials and methods: A total of 2905 cases (1381 female, 1524 male) with an age range between 16 and 84 is included.

Results: PIT was observed in 1.72% of the cases with a percentage of 1.88% in women and 1.57% in men. In PIT (+) cases the bilaterality was found in 54% of them.

According to the subtypes, 70% was lamellar, 28% was bullous and 2% was extensive.

No statistically significant difference was found for age distribution. The most commonly associated variations were the pneumatization of the middle and upper turbinate and the septal deviation.

Conclusions: PIT is a rare variation with a similar frequency among men and women. It is diagnosed by CT and when symptomatic the optimal treatment is surgery.

Key words: inferior turbinate, pneumatization, coronal CT, paranasal sinus region, anatomic variations

INTRODUCTION

Three turbinates are located bulging along the lateral wall of the nasal cavity. Upper and middle turbinates are the parts of the ethmoid bone whilst inferior turbinate is an independent bone of the splanchnocranium. These structures which are lined by mucosa and known as intranasal conchas have role in humidification and filtration of the air, thermoregulation and sniffing. Inferior turbinate with a triangular shape is an anatomical landmark of the nasolacrimal channel.

Concha bullosa defines the pneumatization of the turbinates with air balloons in the concha and generally seen in the middle turbinate. The pneumatization of the inferior turbinate (PIT) is an extremely rare variation which is needed to be kept in mind in functional endoscopic sinus surgery. Pneumatization can be seen as an isolated abnormality with unilateral or bilateral localization however PIT can also be associated with different abnormalities such as intra and/or extrasinusal pneumatizations and other rhinosinusal abnormalities [1]. It is difficult to differentiate PIT and hypertrophia of the inferior concha clinically and endoscopically. The most effective method to differentiate these two entities is the computerized tomography of the paranasal sinuses.

The aim of this study is to define the presence and the frequency of the pneumatized inferior turbinate in CTs. The pneumatized inferior turbinate should be kept in mind as a variation by radiologists and clinicians in order to explain the bulging of the inferior turbinate into the nasal cavity.

MATERIALS AND METHODS

Our retrospective study was designed as the observation of the CTs performed to 3099 patients (1652 male, 1447 female) between January 2012 and December 2016 in Department of Radiology, Muğla Sıtkı Koçman University with a local ethical committee approval.

Patients with an age under 16 or who had paranasal surgical procedure were excluded in addition to the patients whose paranasal anatomy was unable to determine. After exclusion 2905 cases with an age range of 16 to 84 were included in the study. The age distribution was found between 16-84 in men (1524 cases-52.46%) and 16-81 in women (1381 cases- 47.54%). The mean age of the male patients was 36.64 ± 14.64 , whereas the mean age of the female patients was 37.09 ± 13.85 .

The sections of CT was obtained from 16 sliced (Siemens, Somatom Emotion, Germany) and double tubed - 256 sliced (Siemens, Somatom Definition Flash, Germany) MDRB operators. The sections of the paranasal sinus CT were measured as 3mm thickness, 1 pitch, 110 Kv and 70 mAs. The evaluation was done in coronal and reformate axial plan of the CT images.

The patients were grouped according to gender and the images were evaluated for the presence of the PIT. PIT was then subgrouped as bullous type (pneumatization was located in the lower part or the bullous part of the turbinate), lamellar type (pneumatization was located in the vertical lamellar part) and extensive type (pneumatization was located in both parts) according to the classification of Bolger et al [2]. In cases with PIT, associated paranasal sinus abnormalities were also noted.

RESULTS

PIT was observed in 50 of 2905 cases (1.72%). Twenty six of these 50 cases were female. The age range of the PIT (+) female and male patients was 16-69 and 17-62, respectively. The mean age of the female patients was $30,73 \pm 12,72$ whilst male patients was $29, 75 \pm 9, 28$. PIT was unilateral in 23 cases (46%) and bilateral in 27 cases (54%). Fourteen (52%) of 27 unilateral PIT (+) cases was located in the right nasal cavity whereas 13 (48%) showed left localization (Figure 1). According to the classification of Bolger et al, 35 cases were lamellar type (70%), 14 were bullous type

(28%) and 1 case (2%) was extensive type (Tables 1-3, Figure 2). In bilateral cases, the same type of pneumatization was observed and noted in the same group.

The percentage of PIT was 1.88% (n=26) in women and 1.57% (n=24) in men. No statistically significant difference for frequency of PIT between men and women was found despite the predominance in women (X-squared = 0.406, p = 0.5239).

The lamellar type of pneumatization was the most common type and the bullous type was the second most common type in both genders. The extensive type was seen in only one woman (Table 1 and 2).

The abnormalities of the paranasal sinus associated with pneumatization was given in Table 3. The most common abnormality associated with PIT was the pneumatization of middle concha (64%) (Table 3).

DISCUSSION

Inferior turbinate lined by cavernous vascular rich mucosa and developed independently from the lateral wall of the nasal cavity is the largest of the conchas play important role in the regulation, heating and filtration of the air flow [1-3]. Changes in the skeleton of the inferior turbinate which is involved in the formation of the nasal valve and the narrowest region of the nasal passage, or the increased volume of the mucosa may affect nasal patency.

Pneumatization of the superior and middle turbinates is relatively common variation seen in paranasal sinus tomographies. However, pneumatization of the inferior turbinate (PIT) is rare [4,5]. The ventilation of the turbinates was firstly described by Santorini in the middle turbinate in 1793. PIT was firstly described by Zinreich et al in 1988 [4]. Surgical interventional procedures were mostly located in the middle meatus and surrounding area and the delayed diagnosis of PIT due to asymptomatic presentation are the most common reasons of the limited number of studies and few case reports in the literature [6].

By the technological developments of computerized tomography, the anatomical variations of paranasal sinuses and bones are started to be diagnosed more [3,5]. PIT which is a rare variation is generally diagnosed incidentally by imaging studies [3,7].

There were studies focusing on the pathogenetic mechanisms of PIT however no certain etiological reason was found. The most commonly accepted hypothesis of the pathogenetic mechanisms are associated with embryological development of the inferior turbinate. Inferior turbinate develops from prochordal plaque at the 6-8th embryonal weeks on the lateral wall of the nose [8,9]. Two chondral lamellas and 2 separate ossification centers are seen on the inferior concha at 5-7th months [10] and the development continues after birth [11]. The invagination of the epithelium into the double lamellar tissue is thought to be one of the etiological reasons of the pneumatized concha [3]. The secondary theory focuses on the possible role of the maxillary sinus disease and its close relation to the traction zone of the inferior turbinate [12]. The third theory suggests that the extension of the ventilation of the maxillary sinus to the inferior concha in the fetal life may result PIT [13,14].

The incidence of PIT was reported as 0.03 – 4.88% in the studies performed by CT [1,6,13,15]. We found the incidence of PIT 1.72% in our study. The lamellar type pneumatization is the most common type according to the classification of Bolger et al. Thirty five of 50 patients (70%) had lamellar type, 14 had bullous type (28%) and one case had extensive type of pneumatization (2%). Twenty three cases (46%) were bilateral whilst 27 (54%) were unilateral.

The frequency of the pneumatization of the middle concha was higher in females [7]. But the same data for the inferior turbinate was limited. In the study of Öztürk et al reported that PIT is similar in both genders however Baldea et al suggested the slight predominancy among women but no significant difference was found [1,9]. We also found that pneumatization is more common in females similar with the study of Baldea et al however no significant difference was found ($p = 0.5239$).

Variations are common in paranasal sinus region. In the study of Baldea et al, with 250 cases, 10 pneumatization was detected and 9 of these cases also had extrasinusal or sinusal pneumatizations. In addition to that, 7 of these 10 cases had various anatomical variations [1]. Braun and Stammberger reported a cases of pneumatization in 5 conchas except the inferior turbinate [5]. In our study, the associated paranasal sinus abnormalities with pneumatization were found as ventilation of the middle turbinate 64.0% (n=32), onoid cells 42.0% (n=21), 38% (n=19) ventilation of the superior turbinate and septal deviation 38% (n=19).

Depending on the similarity of the epithelium in the air gaps between the conchas and other sinusal cavities, similar inflammatory diseases may accompany with pneumatization [2]. In addition to that, over-ventilated conchas may form mass effect and cause the obstruction in the nasal cavity and sinus infections by effecting ostemeatal drainage [14]. In the study of Baldea et al [1], 8 of 10 pneumatized cases had symptoms of rhinosinusal infection. In these cases, they stated that due to the other extra-pneumatizations accompanying them, only the effect of PIT could not be fully demonstrated.

PIT may cause runny nose, sneeze and headache due to it's degree [3,7]. Nasal congestion due to PIT is rare however may affect quality of life. Especially extensive PIT may cause epiphora because of the contraction of the nasolacrimal duct [16]. The differentiation between the hypertrophia of the inferior turbinate and PIT is almost impossible[3]. Clinically in patients diagnosed as hypertrophia of the inferior turbinate, PIT should be kept in mind when medical treatments are ineffective [3]. The final diagnosis can be given by paranasal sinus CTs. The treatment for PIT is only indicated when the patient is symptomatic [17]. Medications such as nasal steroids can be given but generally they are ineffective and surgery is needed [3]. When surgery is necessary, partial resection is preferred rather than total turbinectomy preventing from atrophic rhinitis aiming to widen the airway to maximum, preserve the function of the nasal mucosa and minimize the complications [4].

We aimed to give more accurate ratios for the frequency of PIT by coronal CT images in our study. The images were analyzed considering that inferior turbinate may be confused with extended nasolacrimal duct or can be misinterpreted with extreme folding of the bone or mucosa of the inferior turbinate as Braun et al reported [5,6].

CONCLUSIONS

The pneumatization of the inferior turbinate is an anatomical variation which can be seen in any age of both genders unilateral or bilateral. Other conchal pneumatizations and septal deviation may accompany. The final diagnosis is given upon CT images. Because of the presence of the anatomical variations of the paranasal region may

complicate surgical procedures; radiologists and surgeons working around this region should remember PIT in order to prevent complications.

Ethical approval

Ethical approval was taken from the ethical committee of the clinical investigations of Muğla Sıtkı Koçman University with grant number of 08.02.2016 / 7.

REFERENCES

1. Baldea V, Cobzeanu MD, Moscalu M. Pneumatization of the inferior turbinate - imaging study. *Rom. J. Rhinol.* 2011; 1(4): 171–87.
2. Bolger WE, Butzin CA, Parsons DS. Paranasal Sinus Bony Anatomic Variations and Mucosal Abnormalities. *Laryngoscope.* 1991; 101(1 Pt 1): 56-64, doi:10.1288/00005537-199101000-00010, indexed in Pubmed: 1984551.
3. Pittore B, Al Safi W, Jarvis SJ. Concha bullosa of the inferior turbinate: an unusual cause of nasal obstruction. *Acta Otorhinolaryngol Ital.* 2011; 31(1): 47-9, indexed in Pubmed: 21808464.
4. Zinreich SJ, Mattox DE, Kennedy DW, Chisholm HL, Diffley DM, Rosenbaum AE. Concha bullosa: CT evaluation. *Journal of Computer Assisted Tomography.* 1988; 2(5): 778-784.
5. Braun H, Stammberger H. Pneumatization of turbinates. *Laryngoscope.* 2003; 113: 668-672, doi: 10.1097/00005537-200304000-00016.
6. Yasan H, Aynalı G, Akkuş Ö, Yarıktaş M, Doğru H, Baykal B. The frequency of the inferior turbinat anatomic variations. *KBB-Forum.* 2006; 5(1): 12–4.
7. Toplu Y, Bayindir T, Karatas E, Akarcay M. All Concha Bullosa: An Undefined Abnormality of the Lateral Nasal Wall. *Indian J. Otolaryngol. Head and Neck Surg.* 2013; 65(1): 86-8. doi: 10.1007/s12070-012-0592-8, indexed in Pubmed: 24381929.
8. Wang RG, Jiang SIC. The embryonic development of the human ethmoid labyrinth from 8-40 weeks. *Acta Otolaryngol.* 1997; 117(1): 118-22. doi: 10.3109/00016489709118002, indexed in Pubmed: 9039492.

9. Öztürk A, Alataş N, Öztürk E, Şan İ, Sirmatel Ö, Kat N. Pneumatization of the inferior turbinates: Incidence and radiologic appearance. *J. Comput. Assist. Tomogr.* 2005; 29(3): 311-314, doi: 10.1097/01.rct.0000162407.78923.a9, indexed in Pubmed: 15891496.
10. Doğru H, Döner F, Uygur K, Gedikli O, Çetin M. Pneumatized inferior turbinate. *Am J Otolaryngol. - Head Neck Med. Surg.* 1999; 20(2): 139-141 doi: 10.1016/S0196-0709(99)90024-8.
11. Bertolini R, Herrling C. Prenatal development of connective and supportive tissue in the inferior nasal concha of man. *Z Mikrosk Anat Forsch.* 1980; 94(6): 1009-20, indexed in Pubmed: 7281877.
12. Namon AJ. Mucocele of the inferior turbinate. *Ann. Otol. Rhinol. Laryngol.* 1995; 104(11): 910-2, doi: 10.1177/000348949510401115.
13. Yang BT, Chong VFH, Wang ZC, Xian JF, Chen QH. CT appearance of pneumatized inferior turbinate. *Clin Radiol.* 2008; 63(8): 901-5, doi: 10.1016/j.crad.2008.01.011, indexed in Pubmed: 18625355.
14. San T, San S, Gürkan E, Erdoğan B. Bilateral Triple Concha Bullosa: A Very Rare Anatomical Variation of Intranasal Turbinates. *Case Rep Otolaryngol.* 2014; 2014:851508, doi: 10.1155/2014/851508, indexed in Pubmed: 25525542.
15. Ozcan KM, Selcuk A, Özcan I, Akdogan O, Dere H. Anatomical Variations of Nasal Turbinates. *J Craniofac Surg.* 2008; 19(6): 1678-1682, doi: 10.1097/SCS.0b013e318188a29d.
16. Ingram A, Richardson BE. Concha bullosa of an inferior turbinate. *Ear Nose Throat J.* 2003; 82(8): 605-7.
17. Şereflican M, Halıcioğlu S, Seyhan S. Inferior Concha Bullosa Communicating into the Maxillary Sinus : Case Report. *Ann Otolaryngol Rhinol* 2016; 3(3): 1096.

Table 1. The frequency and the distribution of PIT according to gender

	Number of cases n	Total n (%)	Lamellar n (%)	Bullous n (%)	Extensive n (%)
Female	1381	26 (52%)	16 (32%)	9 (18%)	1 (2%)
Male	1524	24 (48%)	19 (38%)	5 (10%)	0 (0%)
Total	2905	50 (100 %)	35 (70%)	14 (28%)	1(2%)

Table 2. PIT according to gender and localization

	Lamellar type			Bullous type			Extensive type			Total n
	Right	Left	Bilateral	Right	Left	Bilateral	Right	Left	Bilateral	
	n	n	n	n	n	n	n	n	n	
Female	5	7	4	2	0	7	0	1	0	26
Male	7	5	7	0	0	5	0	0	0	24
Total	12	12	11	2	0	12	0	1	0	50

Table 3. Other paranasal variations associated with PIT

	Female n	Male n	Total n
Pneumatization of the middle turbinate	18	14	32
Onoidi cell	10	11	21
Pneumatization of the upper turbinate	10	9	19
Septal deviation	8	11	19
Haller Cell	5	8	13
Pneumatization of the crista galli	8	2	10
Paradoxical middle turbinate	1	1	2
Uncinate bulla	1	1	2
Paradoxical inferior turbinate	1	0	1

Figure 1. Different types of inferior turbinate pneumatization. **a:** bullous type on the right side in a 17-year-old female. **b:** bullous type on the right side with extensive type on the left side in a 21-year-old female. **c:** bilateral bullous type in a 20-year-old female. **d:** bilateral lamellar type in a 17-year-old male.

Figure 2. The frequency of the types of PIT according to gender



