CASE REPORT

RJME
Romanian Journal of Morphology & Embryology
http://www.rjme.ro/

Variant anatomy of nasal turbinates: supreme, superior and middle conchae bullosae, paradoxical superior and inferior turbinates, and middle accessory turbinate

NICOLETA MĂRU[1)], MUGUREL CONSTANTIN RUSU[1)], MIHAI SĂNDULESCU[2)]

[1)]*Division of Anatomy, Faculty of Dental Medicine, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania*

[2)]*Division of Oral Implantology, Faculty of Dental Medicine, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania*

Abstract

Multiple anatomical variants were encountered during a cone beam computed tomography (CBCT) study of the nasal cavity of a 43-year-old male patient. These were mostly related to the nasal turbinates, suggestive for an unusual development of ethmoturbinals. Pneumatized turbinates were observed: bilateral supreme, superior, and middle concha bullosa. There were bilateral paradoxically curved superior turbinates, as well as a unilateral paradoxically curved inferior turbinate. There was also found a unilateral accessory middle turbinate, presenting as a medially bent uncinate process. Due to the presence of the Santorini's concha, the natural ostium of the sphenoidal sinus was medial to it, and was not directly related to the superior turbinate. Such variants, alone or in combination, should be documented prior to surgical procedures, endoscopic or microscopic, by rhinologists and neurosurgeons, prior to various sinonasal or skull base approaches. Patients should be evaluated on a case-by-case basis, as the Vesalian anatomy could not apply to all.

Keywords: nasal fossa, rhinology, nasal turbinate, concha bullosa, paradoxical turbinate, Santorini's concha.

Introduction

The nasal turbinates are important anatomical structures within the nasal cavity [1]. While the inferior one is a separate bone, the other are parts of the ethmoid bone. Their position and relationship to other important anatomic landmarks is extremely important especially in non-invasive endoscopic skull base and ENT (ear, nose, and throat) surgical procedures.

A paradoxical middle turbinate (PMT) refers to an inferomedially curved middle turbinate edge with the concave surface facing the nasal septum [2]. It usually occurs bilaterally [2].

This anatomic variant alone can lead to significant narrowing of the middle nasal meatus (MNM) and impedes the normal drainage of paranasal sinuses due to ostiomeatal complex obstruction [2].

When associated with a bulbous middle turbinate, PMT can potentially lead to nasal obstruction [2].

A concha bullosa is generally defined as the pneumatization of the middle turbinate [2, 3]. However, superior and inferior concha bullosa are also encountered, these being pneumatizations of the superior and inferior turbinates, respectively [3–7]. This is the reason why concha bullosa is better defined as "the presence of air cells in turbinates" [8]. Pneumatizations of all three turbinates, superior, middle and inferior ("panconcha bullosa") is extremely rare, and seemingly only three cases were reported until now [8–10]. The supreme concha bullosa was not previously reported.

The secondary middle turbinate (SMT) is a rare anatomical nasal cavity variation, which was reported in 0.8% to 6.8% of cases [11]. The SMT is a bony projection originating from the lateral wall of the middle meatus [11]. The accessory middle turbinate (AMT) is defined as a medially bent uncinate process and is developmentally distinctive to the SMT [11].

We present here a case with previously unreported, or rare, combined variants of the nasal turbinates.

Case report

During a cone beam computed tomography (CBCT) study performed retrospectively on a group of subjects for various dental procedures, in a male patient of 43 years, we observed multiple rare anatomic variants of the nasal turbinates. The subjects were scanned using an iCat CBCT machine (Imaging Sciences International, Hatfield, PA, USA), and the CT data were analyzed using the iCatVision software and the application 3DVR *ver.* 5.0.0.3, for the 3D reconstructions, according to a specific protocol previously described [12]. We analyzed bidimensional multiplanar reconstructions (MPRs) in the axial, coronal and sagittal planes.

In this particular patient, we noticed a right nasal septal deviation, which associated the hypertrophy of the soft tissue component of the left inferior turbinate (Figure 1). We also found bilateral horizontal septal crests. Such an inferior crest was corresponding to the paradoxical curvature of the right inferior turbinate (Figure 2).

We classified the multiple anatomic variants of the nasal turbinates we found as follows: (a) in the left middle

nasal meatus a left accessory middle turbinate was found deriving from a medially bent uncinate process (Figure 3); (b) the inferior turbinates were not pneumatized but the middle turbinates were, that middle conchæ bullosæ being of lamellar type, with pneumatizations within the vertical lamellæ of middle turbinate; (c) we found bilateral pneumatized superior turbinates, thus superior conchæ bullosæ (Figure 1B); (d) in their posterior parts the superior turbinates were paradoxically curved (paradoxical upper turbinates, Figure 1, C and D); (e) on each side the posterior ethmoid was projecting supreme nasal turbinates (the Santorini's conchæ or highest nasal conchæ), and these were also pneumatized (bilateral supreme conchæ bullosæ – Figure 1, A, C and D); (f) as determined by the presence of Santorini's conchæ, on each side the ostium of the sphenoidal sinus was opening medially to these (Figure 1A), and not to the superior turbinates, in the sphenoethmoidal recess; (g) between the supreme and superior turbinates, on each side, a nasal supreme meatus was configured.

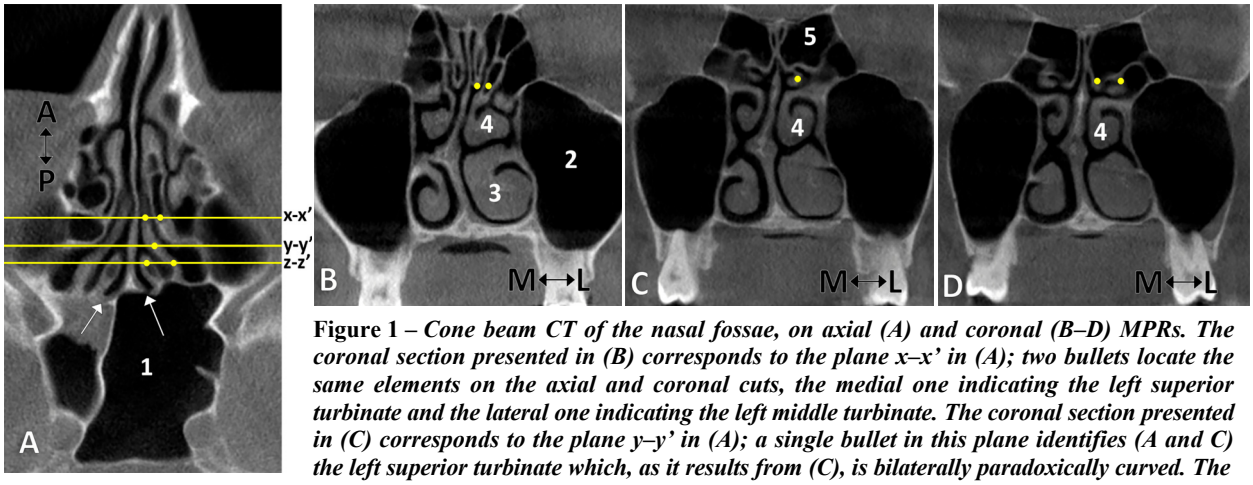

Figure 1 – ***Cone beam CT of the nasal fossae, on axial (A) and coronal (B–D) MPRs. The coronal section presented in (B) corresponds to the plane x–x' in (A); two bullets locate the same elements on the axial and coronal cuts, the medial one indicating the left superior turbinate and the lateral one indicating the left middle turbinate. The coronal section presented in (C) corresponds to the plane y–y' in (A); a single bullet in this plane identifies (A and C) the left superior turbinate which, as it results from (C), is bilaterally paradoxically curved. The coronal section presented in (D) corresponds to the plane z–z' in (A); two bullets locate the same elements on the axial and coronal cuts, the medial one indicating the left supreme turbinate and the lateral one indicating the left superior turbinate. M: Medial; L: Lateral; A: Anterior; P: Posterior. The arrows in (A) indicate the ostia of the sphenoidal sinuses. 1: Left sphenoidal sinus; 2: Left maxillary sinus; 3: Left inferior turbinate; 4: Left middle turbinate; 5: Posterior ethmoid air cell.***

Figure 2 – ***Cone beam CT coronal MPR of the nasal fossae. On the right side, we identified a paradoxical inferior turbinate (arrow) and a corresponding horizontal septal crest (arrowhead).***

Figure 3 – ***Cone beam CT coronal MPR of the nasal fossae. On the left side, we identified an accessory middle turbinate (arrow) deriving from the uncinate process.***

Discussion

Multiple anatomic variants were found in the present case, most of these being related to the nasal turbinates. The nasal turbinates, as well as the paranasal sinuses, arise from the cartilaginous nasal capsule [13]. During the development of the skull, five ethmoturbinals and the maxilloturbinal are formed, but the first ethmoturbinal disappears. The inferior turbinate results from the maxilloturbinal. The middle turbinate forms from the second ethmoturbinal, the superior turbinate from the third ethmoturbinal and the supreme turbinate from the fourth ethmoturbinal [13].

The supreme nasal concha of Santorini is a rare anatomic variant and the supreme concha bullosa was not previously reported. In such cases, the natural ostium of the sphenoidal sinus is located medial to the Santorini's concha and not to the superior turbinate, as it is usually considered [14]. The location of the sphenoidal sinus ostium is important in a variety of surgical procedures for the removal of benign or malignant lesions [14].

Such a possible anatomic variation is of great interest for neuro-rhinologic endoscopic approaches targeting the skull base [15].

The superior concha bullosa is a rare variation, symptomatic or not [3], and there are few cases documented, which presented panconcha bullosa (see "Introduction"). However, in the present case, the inferior turbinates were not pneumatized, thus a panconcha bullosa could not be assessed. On the other hand, the paradoxical superior turbinates variant was not previously reported. This should be also taken into account during endoscopic endonasal approaches of the skull base. This transnasal corridor is used in endoscopic or microscopic direct approaches of the skull base, or could combine trans-sinusal corridors, such as the sphenoidal, ethmoidal, or maxillary, to approach the middle fossa [16]. Also, the exact position of the superior

turbinate must be assessed preoperatively, as postoperative hyposmia can result after an injury of the superior turbinate [17].

The middle concha bullosa is a common finding [1, 10, 18–20] but statistically significant correlations between sinonasal anatomic variations, such as concha bullosa or agger nasi cells, and paranasal sinuses pathologies were not found [19, 20]. However, such variations are clinically relevant, and ethnical differences in the prevalence of such variations were discussed [21]. A strong association between the presence of a concha bullosa and contralateral deviation of the nasal septum was assessed but the nasal septal deviation away from the dominant turbinate was not a direct result of mass effect from the turbinate [20].

Three types of middle concha bullosa were described, lamellar, bulbous and extensive, but no statistically significant differences were found between these in terms of sinus pathology [22].

We also found a unilateral paradoxically curved inferior turbinate. This is, in our opinion, the second report of such variant of the inferior turbinate. Previously, the case of a 13-year-old female patient was reported, who presented a paradoxical huge inferior turbinate, which blocked that nasal fossa and deviated the nasal septum contralaterally [23]. In the present case, we speculate that the inverse conformation of the right inferior turbinate was related to, or determined by the corresponding horizontal septal nasal crest.

The AMT was previously reported [11] in a combination with a SMT protruding from the lateral wall of nasal fossa. Intranasal endoscopy and coronal CT help to distinguish between these two developmentally different variants [11]. The AMT was found in 6.8% of 384 patients, was bilateral in 46.2%, unilateral in 53.8% and in 38.4% there was a concomitant mucosa pathology [1]. Such double middle nasal turbinates could be encountered in rhinology practice (2%) and may present clinically with headache and blocked nose, endoscopic surgery being an effective way for improving the clinical picture [24].

Two conclusive remarks should be considered here. First, as we repeatedly commented [25, 26] in accordance with Bergman [27, 28], the Vesalian anatomy is usually overridden by anatomic variation. This should be strongly taken into account by clinicians. Second, cone beam computed tomography appears to be an indispensable tool for evaluating patients prior to any surgical procedure, on a case-by-case basis, within the concept of personalized medicine.

Conclusions

CBCT is a reliable tool to evaluate the variations of the nasal fossa osseous anatomy. We present here the supreme concha bullosa and paradoxical superior turbinate variants, which were not reported previously, in our knowledge.

Conflict of interests

The authors declare that they have no conflict of interests.

References

[1] Ozcan KM, Selcuk A, Ozcan I, Akdogan O, Dere H. Anatomical variations of nasal turbinates. J Craniofac Surg, 2008, 19(6): 1678–1682.

[2] Neskey D, Eloy JA, Casiano RR. Nasal, septal, and turbinate anatomy and embryology. Otolaryngol Clin North Am, 2009, 42(2):193–205, *vii*.

[3] San T, Erdoğan B, Taşel B. Bilateral superior concha bullosa: a rare case overlooked. Kulak Burun Bogaz Ihtis Derg, 2014, 24(5):292–294.

[4] 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):47–49.

[5] Kantarci M, Karasen RM, Alper F, Onbas O, Okur A, Karaman A. Remarkable anatomic variations in paranasal sinus region and their clinical importance. Eur J Radiol, 2004, 50(3):296–302.

[6] Christmas DA, Ho SY, Yanagisawa E. Concha bullosa of a superior turbinate. Ear Nose Throat J, 2001, 80(10):692–694.

[7] Homsioglou E, Balatsouras DG, Alexopoulos G, Kaberos A, Katotomichelakis M, Danielides V. Pneumatized superior turbinate as a cause of headache. Head Face Med, 2007, 3:3.

[8] 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.

[9] Fidan V. Panconcha bullosa: new definition in the literature. J Craniofac Surg, 2012, 23(3):e253–e254.

[10] Ozturan O, Yenigun A, Degirmenci N, Yilmaz F. 'Conchae bullosis': a rare case with bilateral triple turbinate pneumatisations. J Laryngol Otol, 2013, 127(1):73–75.

[11] Lin YL, Lin YS, Su WF, Wang CH. A secondary middle turbinate co-existing with an accessory middle turbinate: an unusual combination of two anatomic variations. Acta Otolaryngol, 2006, 126(4):429–431.

[12] Rusu MC, Didilescu AC, Jianu AM, Păduraru D. 3D CBCT anatomy of the pterygopalatine fossa. Surg Radiol Anat, 2013, 35(2):143–159.

[13] Som PM, Naidich TP. Illustrated review of the embryology and development of the facial region, part 1: Early face and lateral nasal cavities. AJNR Am J Neuroradiol, 2013, 34(12): 2233–2240.

[14] Kim HU, Kim SS, Kang SS, Chung IH, Lee JG, Yoon JH. Surgical anatomy of the natural ostium of the sphenoid sinus. Laryngoscope, 2001, 111(9):1599–1602.

[15] Craiu C, Sandulescu M, Rusu MC. Variations of sphenoid pneumatization: a CBCT study. Rom J Rhinol, 2015, 5(18): 107–113.

[16] Schwartz TH, Fraser JF, Brown S, Tabaee A, Kacker A, Anand VK. Endoscopic cranial base surgery: classification of operative approaches. Neurosurgery, 2008, 62(5):991–1002; discussion 1002–1005.

[17] Orlandi RR, Lanza DC, Bolger WE, Clerico DM, Kennedy DW. The forgotten turbinate: the role of the superior turbinate in endoscopic sinus surgery. Am J Rhinol, 1999, 13(4):251–259.

[18] Tiwari R, Goyal R. Study of anatomical variations on CT in chronic sinusitis. Indian J Otolaryngol Head Neck Surg, 2015, 67(1):18–20.

[19] Kaygusuz A, Haksever M, Akduman D, Aslan S, Sayar Z. Sinonasal anatomical variations: their relationship with chronic rhinosinusitis and effect on the severity of disease – a computerized tomography assisted anatomical and clinical study. Indian J Otolaryngol Head Neck Surg, 2014, 66(3):260–266.

[20] Stallman JS, Lobo JN, Som PM. The incidence of concha bullosa and its relationship to nasal septal deviation and paranasal sinus disease. AJNR Am J Neuroradiol, 2004, 25(9):1613–1618.

[21] Al-Abri R, Bhargava D, Al-Bassam W, Al-Badaai Y, Sawhney S. Clinically significant anatomical variants of the paranasal sinuses. Oman Med J, 2014, 29(2):110–113.

[22] Hatipoğlu HG, Cetin MA, Yüksel E. Concha bullosa types: their relationship with sinusitis, ostiomeatal and frontal recess disease. Diagn Interv Radiol, 2005, 11(3):145–149.

[23] Naiboğlu B, Yaylacı A, Oysu C. Paradoxical giant inferior concha. Ear Nose Throat J, 2011, 90(7):E18–E19.

[24] El-Shazly AE, Poirrier AL, Cabay J, Lefebvre PP. Anatomical variations of the lateral nasal wall: the secondary and accessory middle turbinates. Clin Anat, 2012, 25(3):340–346.

[25] Rusu MC, Vrapciu AD, Pătraşcu JM. Variable relations of the trochlear nerve with the pontomesencephalic segment of the superior cerebellar artery. Surg Radiol Anat, 2015, 37(5):555–559.
[26] Ilie OC, Ciuluvică RC, Rusu MC. Anatomic variation of alveolar antral artery. Folia Morphol (Warsz), 2015, 74(2):192–194.
[27] Bergman RA. Thoughts on human variations. Clin Anat, 2011, 24(8):938–940.
[28] Duparc F. Reply to "Thoughts on human variations". Clin Anat, 2011, 24(8):944.

Corresponding author
Mugurel Constantin Rusu, Professor, MD, PhD, Dr.Hab., Division of Anatomy, Faculty of Dental Medicine, "Carol Davila" University of Medicine and Pharmacy, 8 Eroilor Sanitari Avenue, 050474 Bucharest, Romania; Phone +40722–363 705, e-mail: mugurel.rusu@umf.ro

Received: March 27, 2015

Accepted: November 28, 2015