Anatomical variants in the sino-nasal region: a pictorial review

Poster No.: C-2406
Congress: ECR 2015
Type: Educational Exhibit
Keywords: Diagnostic procedure, CT, Ear / Nose / Throat, Neoplasia, Chronic obstructive airways disease
DOI: 10.1594/ecr2015/C-2406

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

- To illustrate the anatomical variants encountered during computerized tomography (CT) of the sino-nasal region.

- To discuss the clinical importance of the anatomical variations and how they may affect the management of inflammatory diseases of the sino-nasal region.
Background

Radiologists and otorhinolaryngologist rely on cross-sectional imaging, especially CT, as a roadmap for the pre-operative work up of the patients presenting with inflammatory sino-nasal disease. Knowledge of the anatomy and the variants is paramount in planning surgical treatment.

Many potential operative complications can be avoided by careful interpretation of the pre-operative CT scans.
Findings and procedure details

A. Anatomic Variant With Risk Of Chronic Rhinosinusitis

1. NASAL SEPTUM VARIATION (fig 1)

The nasal septum is fundamental in the development of the nose and paranasal sinuses. It is "epiphyseal platform" for the development of the facial skeleton. The three components of the adult nasal septum (septal cartilage, perpendicular plate for ethmoid lamina, and delimited by the vomer) give rise to a deviation of the septum.

Septal deviation is a shift of the midline associated with deformities or asymmetry of the adjacent turbinates.

2. MIDDLE TURBinate VARIATION

Paradoxical Middle Turbinate (fig 2)

In this variation, the convexity of the middle turbinate is on the lateral side. The major consequence of these anatomic variations is narrowing of the middle meatus which can lead to obstruction of infundibular drainage. However the degree of convexity of the middle turbinate is the most important factor to cause the obstruction which will lead to rhinosinusitis. Paradoxical middle turbinate is known to abut against lateral wall and the middle meatus as compared to a normal shaped middle turbinate. It has formed the basis for contact point theory resulting into disturbance with mucocilliary clearance which further leads to development of CRS and nasal polyps.

Concha Bullosa (fig 3)

Concha bullosa is a variation originated from pneumatization of the bone plate by extension of the ethmoid sinus cells. Such variation may be either uni- or bilateral.

The presence of a concha bullosa ranged between 4% and 80% in different studies.

Varied degrees of pneumatization of the concha may be observed, possibly causing middle meatus or infundibulum obstruction, besides being related to deviation of the nasal septum to the contralateral side.

Classification of the pneumatization of the concha is based on the location as lamellar concha bullosa, bulbous concha bullosa and extensive concha bullosa.

3. UNCINATE PROCESS VARIATIONS
The uncinate process projects from the ethmoid process of the inferior nasal concha and it is a superior extension of the lateral nasal wall that is anatomically relevant for draining the frontal recess.

Variations such as hypertrophy, deviation (fig 4) and pneumatization may affect the drainage, generating abnormalities in the ostiomeatal complex and predisposing to obstruction.

Pneumatization of the uncinate process (fig 5) (uncinate bulla) is a rare entity and this anatomic variation may result in anatomic narrowing of the infundibulum and can impair sinus ventilation.

4. ACCESSORY OSTIUM (fig 6)

Accessory maxillary ostia are generally solitary, but occasionally may be multiple. Such variation may be congenital or secondary to sinusal diseases. Possible mechanisms involved in the development of such variation include: main ostium obstruction, maxillary sinusitis or anatomical/pathological factors in the middle meatus, resulting in rupture of membranous areas.

5. ETHMOID CELLS VARIATIONS

**Haller cells** (fig 7)(infraorbital ethmoid cells) are ethmoid air cells located anteriorly to the ethmoid bulla, along the orbital floor, adjacent to the natural ostium of the maxillary sinus, which may cause mucociliary drainage obstruction, predisposing to the development of sinusitis.

**Agger nasi cells**, which are the most anterior ethmoid cells, are located anteriorly to the upper margin of the nasolacrimal duct and anteriorly to the plane of the maxillary sinus infundibulum.

The agger nasi cell can be an important factor in selected cases of frontal sinusitis.

The giant agger nasi cell caused sinusitis by obstruction of the frontal sinuses' drainage pathway.

**Onodi cells**: The posterior ethmoid cells may invade the posterior ethmoid capsule or migrate to the medial aspect of the optic nerve. These then take the name of Onodi cells (spheno-ethmoid cells) and are located between the sphenoid sinus and the floor of the anterior cranial fossa. This variation is easily seen in 5% of the coronal scans.

The presence of an Onodi cell may possibly contribute to increased risk of injury to the optic nerve and mucocele of an Onodi cell causing optic neuropathy is extremely rare.

**The ethmoid bulla** (fig 8) is the largest air cell of the ethmoid complex. When this air cell reaches sufficient size it can tighten or even obstruct the middle nasal meatus and the infundibulum. Therefore, it is considered as a great ethmoid bulla.
6. PARANASAL SINUSES PNEUMATIZATION EXTENT

In most cases, pneumatization presents recesses related to the greater sphenoid wing, although lateral extensions may also be observed in the smaller sphenoid wing, inferiorolateral and septal recesses.

Frontal sinus extension is a rare condition characterized by increased sinusal aeration beyond the normal margin of the frontal bone that originates from anterior extension of the anterior ethmoid air cells.

Extensions related to the lamina of the frontal bone, crista galli, besides inferior, symmetric extension of the frontal sinus towards the anterior ethmoid cells may also be found.

7. MAXILLARY SINUSES SEPTA

Maxillary sinus septa are thin walls of cortical bone present within the maxillary sinus, with variable number, thickness and length. Such septa may divide the sinus into two or more cavities arising from the inferior and lateral walls of the sinus. Septa originating from teeth may be classified according to their development at different phases of dental eruption.

B. Anatomic variant with surgical risk

1. CAROTID ARTERY VARIATION (fig 9)

The intersphenoid septum is deflected to one side, attaching to the bony wall covering the carotid artery, and thus arterial injury may result when the septum is avulsed during surgery. The artery may bulge into the sinus in 65-72% of patients. There may be dehiscence/absence of the thin bone separating the artery and the sinus in 4-8% of cases.

2. OPTIC NERVE VARIATIONS (fig 10)

The posterior ethmoid has a variable relationship with the sphenoid sinus and is intimately related to the optic nerve. The surgeon cannot assume that the sphenoid sinus is directly posterior to the posterior ethmoid sinus. In some cases, the posterior ethmoid cell may extend laterally or superiorly beyond the anterior wall of the sphenoid sinus. This relationship, if not appreciated, may lead to the potential injury to the optic nerve by an unsuspecting endoscopist. It was reported that the anterior opening of the optic canal may be located adjacent to the most posterior ethmoid cell (50%), at the junction of the posterior ethmoid and anterior sphenoid (25%) or adjacent to the sphenoid sinus (25%).

However, a recent study based on coronal CT showed that the optic nerve is mostly related to the sphenoid sinus rather than the posterior ethmoid sinus.

The relationships between the optic nerve and posterior paranasal sinuses are classified into four groups, as follows:
• Type I: The most common type, it occurs in 76% of patients. Here, the nerve courses immediately adjacent to the sphenoid sinus, without indentation of the wall or contact with the posterior ethmoid air cell.

• Type II: The nerve courses adjacent to the sphenoid sinus, causing an indentation of the sinus wall, but without contact with the posterior ethmoid air cell.

• Type III: The nerve courses through the sphenoid sinus with at least 50% of the nerve being surrounded by air.

• Type IV: The nerve course lies immediately adjacent to the sphenoid and posterior ethmoid sinus.

The sphenoid sinus septa may be attached to the bony canal of the optic nerve, predisposing the nerve to injury during surgery.

3. PNEUMATISATION OF ANTERIOR CLINOID PROCESS

Anterior clinoid process pneumatization is associated with type II and type III optic nerve and predisposes this nerve to injury during FESS.

4. THE PTERYGOID CANAL VARIATION

The pterygoid canal or the groove of the maxillary nerve may project into the sphenoid sinus, causing injury during surgery.

5. THE INFRA-ORBITARY CANAL

The infra-orbitary canal may project into the maxillary sinus, causing injury during surgery.

6. ETHMOID ROOF

The ethmoid roof is of critical importance for two reasons. First, it is most vulnerable to iatrogenic cerebrospinal fluid leaks. Second, the anterior ethmoid artery is vulnerable to injury, which can cause devastating bleeding into the orbit.

During FESS, intracranial injury can occur on the side where the position of the roof is relatively low. The depth of the olfactory fossa is determined by the height of the lateral lamella of the cribriform plate, which is part of the ethmoid bone.

In 1962, Keros had classified the depth of the olfactory fossa into three types:

- Keros type I: <3 mm,
- Keros type II: 4-7 mm, and
- Keros type III: 8-16 mm.

Keros type III is most vulnerable to iatrogenic injury.
Images for this section:

Fig. 1

© Radiology, Farhat Hached - Sousse/TN
Fig. 2

© Radiology, Farhat Hached - Sousse/TN
Fig. 3

© Radiology, Farhat Hached - Sousse/TN
Fig. 4

© Radiology, Farhat Hached - Sousse/TN
Fig. 5

© Radiology, Farhat Hached - Sousse/TN
Fig. 6

© Radiology, Farhat Hached - Sousse/TN
Fig. 7

© Radiology, Farhat Hached - Sousse/TN
Fig. 8

© Radiology, Farhat Hached - Sousse/TN
Fig. 9

© Radiology, Farhat Hached - Sousse/TN
Fig. 10

© Radiology, Farhat Hached - Sousse/TN
Conclusion

We emphasize the importance of identifying anatomical variation in the sino-nasal region. A good understanding between the radiologist and the otorhinolaryngologist is essential to provide optimal surgical intervention with minimal risk.
References