Chapter Five

Imaging of Paranasal Sinuses and Nose

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Radiographic imaging of the nasal cavity and paranasal sinuses are essential for evaluation and planning. The routine imaging has been used for more than 5 decades, by the physicians, they correlate well only in acute sinusitis, indicated by air fluid level. Accurate assessment of the bony framework, soft tissue, anatomical variation, inflammatory and other pathological lesion of the paranasal sinuses and nasal cavity has been only possible with increased availability of CT scans. On the other hand MRI provides more information about soft tissue of the face, head and neck, skull base and central nervous system.

The primary object of CT scan is to provide a road map for endoscopic sinus surgeon by identifying the normal anatomical landmarks and variant anatomy as well as to aid the diagnosis of pathological conditions(1). Though the nasal endoscopy reveals considerable anatomical and pathological information, the extent of the disease together with the surrounding anatomy can only be evaluated by the CT scan employing coronal and axial images. The work of Hilding (2), Proctor (3) and Messer Kilinger (4) on the mucociliary clearance and air flow in the nose and sinuses point out the importance of osteomeatal complex in the pathogenesis of the sinus disease.

The successful outcome of the endoscopic sinus surgery depends upon the evaluation of pathological changes, an anatomical definition of the osteomeatal complex by CT and the re-establishing of the mucociliary clearance and ventilation of the sinuses with functional endoscopic sinus surgery by limited resection and preserving the sinus mucosa which will become normal hence afterwards.

The osteomeatal complex, the ethmoid sinuses, maxillary sinuses and its ostium sphenoid sinuses, frontal recess and agar nasi cells, middle turbinate, uncinate process, and the basal lamella are best visualised by the coronal plane i.e. Direct coronal CT scanning (Fig 1-3).

![Fig.1. Frontal sinuses](image1)

![Fig.2. Middle turbinate and basal lamella](image2)

![Fig.3. Sphenoid sinuses](image3)

The axial images are excellent to show the vital structures such as carotid artery, optic nerve and the relation of posterior ethmoidal cell such as Odoni cell to the optic nerve and Sphenoid Sinus (Fig 4).
The Osteomeatal complex is defined as the physiological unit providing airflow and mucociliary clearance to the maxillary, ethmoid, frontal and sphenoid sinuses. Anatomically the otolaryngologist refers this area bounded medially by the middle turbinate, laterally by the lamina papyracea and uncinate process, the basal lamella superiorly and posteriorly. The inferior and anterior borders are open (Fig 5-6).

The coronal CT scan of the paranasal sinuses is performed with the patient in the prone position with the head hyper extended, 3mm of thin coronal section are obtained from the frontal sinus to sphenoid sinus. The CT scan images should be photographed on bone (average 2000H windows) setting as well as soft tissue (average 250H windows) settings. The bone windows settings are best to define the detailed anatomy as well as pathology of the OMC, ethmoid sinus, uncinate process, the frontal recess, the frontal and the sphenoid sinus. However the soft tissues setting will help the physician to evaluate the pathological changes in the orbit, intracranial as well as in the nose and sinuses.

The frontal sinus appears at the age of 8 years on the X-ray. The Frontal sinuses are the most variable in size and are asymmetrical. They are aplastic in 17% of various European races, in 12% of Continental European races, in 35% of other races and 52% Eskimos. The frontal sinus drains via the frontal infundibulum to the frontal sinus ostium and then into the frontal recess, thus making an hourglass appearance (Fig 7-8).
In acute cases an air fluid level may be visible. Mucocele appears as an opacification and expansion of the frontal sinus with the loss of haustrations septas. The osteomyelitis of the frontal sinuses will appear as Pots puffy tumours (Fig 10b).

The nasolacrimal duct appears as a vertically oriented tubular structure with well defined cortical margins filled by soft tissue, extending from lacrimal fossa to the level of the inferior turbinate (Fig 11).

Recognition of the importance of OMC has increased the role of the radiologist to evaluate and identify different anatomical anomalies as well as pathological process in this key area. The ethmoid is a delicate bone which articulates with thirteen bones, the frontal, the sphenoid, the nasal bone, the maxilla, the palate, the vomer and the inferior nasal conchae (5). The ethmoid bone consists of four parts e.g. a perpendicular plate, two labyrinths and a horizontal plate, called the cribriform plate. Each ethmoid labyrinth comprised of vertically oriented air cells up to eighteen in number that are separated so that they form honey comb of mucosa lined spaces that drain into each other (6). The most prominent air cell is bulla ethmoidalis, bordered anteroinferiorly by the hiatus semilunaris and infundibulum from back to front respectively. The lamina papyracea forms the lateral wall of the ethmoid sinus. The supra bullar recess may lead to a space superio-posteriorly, between the posterior wall of the bulla ethmoidalis and basal lamella called sinus lateralis (Fig 12 -13).
The ostia of ethmoid sinus cannot be visualised by CT scan. The anterior, most intramural, ethmoidal cells are the frontal recess cells. The infundibular cells are the next most anterior ethmoidal cells, from here arise the agger nasi cells, located immediately anterior to the anterior end of the middle turbinate. Just inferior and posterior to the agger nasi cells lies the uncinate process, a boomerang shaped bone subjected to considerable variation. It is about 1-4 mm wide and 14-22 mm long, forms the medial boundary of the hiatus semilunaris (7). As it progresses postoinferiorly it forms the inferior border of the hiatus semilunaris and the medial wall of the infundibulum. The infundibulum is trough shaped cavity below the bullae and above and lateral to the uncinate process (Fig 14-17).
usually the largest and separate bone while the superior conchae are the parts of ethmoid bone. The nasolacrimal ducts open in the inferior meatus.

The superior turbinate is the smallest and anchored superiorly to the cribriform plate. The middle turbinate attaches to ethmoid roof at the lateral lamella of the cribriform plate anteriorly via ground lamella. The middle turbinate inserts laterally to the lamina papyracea via the basal lamella posteriorly. The fovea ethmoidalis is separated from the cribriform plate by the ground lamella of the middle turbinate. The fovea ethmoidalis, normally is situated at a higher level, occasionally this may be reversed and worthy of notice to avoid the potential complications during surgery. The most common anatomical variation is the pneumatization of the middle turbinate called conchum bullosa and is present in about 30% of the patients (Fig 18-19).

This may occur on one side or both side (7). The uncommon variant are Odoni cell and Haller cells (Fig 20).

The ethmoid sinuses are the commonest site for inflammation manifested as thickening of the mucosa. Mucocele of the ethmoid sinuses may present as proptosis or lateral displacement of the eye and most often involves the anterior ethmoid air cells (Fig 21-27).
Polyps appears as expansile masses with the opacification of sinuses and without the destruction of the bony walls. The malignancies will destroy the bony walls without remodelling and will enhance with contrast. Allergic fungal Sinusitis is manifested by the involvement of sinuses with area of attenuation between 180-320 Hounsfield units surrounded by an area of hypointensity, thus creating double density due to the concretion surrounded by allergic mucin (Fig 28-30).
The sphenoid sinus is the most posterior sinus with a variable pneumatisation and septation. They start pneumatization after the age of three years and grow to an average adult size of 2cm high and 2.3 cm deep and 1-7 cm wide. The internal carotid artery and optic nerve are adjacent to the posterolateral aspect of the sphenoid sinus and may produce two corresponding bulges, on occasions the bony wall may be deficient (8). Acute sinusitis may be represented by the fluid level and the polyps in allergic fungal sinusitis may also involve the sphenoid sinuses and may erode through the walls into the surrounding structures (Fig 31).

References
2- Hilding A: Influence of ciliary activity on the bacteriology of nose. Proc staff meet Mayo clinic 6, no 19, 1931
3- Proctor D; Airborne diseases and the upper respiratory tract. Bacteriology Review 1966; 30-49, 8
5- Terrier F, Webber W, Rufencht D, Porcellin B: Anatomy of ethmoid; CT endoscopic; Am J Rhinol 1: 493-500, 1985
Van Ayea OE; 1951 Nasal sinuses, an anatomical and clinical consideration. 2nd edition Baltimore(MD) William Wilkins

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