Imaging of Paranasal Sinuses and Anterior Skull Base and Relevant Anatomic Variations

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KEYWORDS

• Anterior skull base • Sinonasal cavity • Computed tomography • MR imaging • Neoplasm • Inflammatory disease

KEY POINTS

- The anterior skull base (ASB) is the boundary between the anterior cranial fossa and sinonasal cavities and orbits.
- In addition to the intrinsic ASB lesions, sinonasal lesions extend superiorly to involve ASB and also intracranial lesions extend to ASB.
- CT and MRI play a complementary role in evaluating and characterizing ASB pathologies.
- Radiologists should be familiar with the detailed anatomy, identify dangerous anatomical variations, provide appropriate differential diagnosis, and assess the extent of the lesion for optimal treatment planning.

INTRODUCTION

The anterior skull base (ASB) is the boundary between the anterior cranial fossa and sinonasal cavities and orbit, consisting of the frontal bone, ethmoid bone, and sphenoid bone. ABS pathologic conditions can be divided into 3 major categories: (1) sinonasal lesions extending cranially, (2) intrinsic ASB lesions, and (3) intracranial lesions involving the ASB.

Computed tomography (CT) and MR imaging play important roles in providing a diagnosis or differential diagnosis, assessing the extent of ASB lesions, and guiding treatment decisions and surgical approach.

The recent advances in the endoscopic sinonasal and skull base surgery allow a minimally invasive surgery for a wide variety of pathologic conditions, including congenital and inflammatory diseases, and benign and malignant neoplasms. Because these endoscopic procedures use sinonasal cavity as surgical corridors, the preoperative evaluation of sinonasal cavity is critical to facilitate the safe access to a target lesion. Radiologists should be aware of sinonasal anatomic variants that can create impediments to surgical access, decrease surgical field orientation, and increase risk of vascular or cranial nerve injury during the surgery.

This article briefly addresses CT and MR imaging techniques and reviews the ASB anatomy. In particular, it describes the sinonasal anatomy and its variants pertinent to endoscopic approach to the skull base. Clinical and imaging findings of ASB pathologic conditions are also discussed.

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IMAGING TECHNIQUE

CT and MR imaging play a complementary role in characterization and determination of the extent of the ASB pathologic condition. CT provides better detail of the bony anatomy and the extent of pneumatization. It also clearly demonstrates presence of calcification, bone remodeling, and destruction, and characterizes fibro-osseous pathologic conditions. MR imaging offers much superior contrast resolution and is useful in delineating the extent of disease and characterizing soft tissue pathologic conditions.

Computed Tomography

Thin axial CT images should be acquired using the multirow detector CT with 0.5 to 0.625 mm collimation to obtain sufficient information about osseous anatomy and pathologic changes in the skull base and sinonasal cavity. Images are reconstructed to axial, coronal, and sagittal planes with high-resolution bone and soft-tissue algorithms.

Noncontrast-enhanced CT is usually sufficient for assessment of fibro-osseous lesion. Contrast-enhanced CT should be considered if there is a clinical concern for extrasinus extension of infection, abscess, venous thrombosis, or neoplasm.

MR Imaging

MR sequences should include T1-weighted images (T1WIs) and T2-weighted images (T2WIs), and contrast-enhanced fat-saturated (CEFS)-T1WI in axial and coronal planes covering the sinonasal cavity to intracranial structures. Thin-slice thickness (2 mm or less) is preferred. T1WI is useful to detect subtle abnormal findings in bone marrow and adipose tissue as well as detection of proteinous secretion, hemorrhage, and melanin. A T1WI with CEFS-T1WI is necessary to delineate an enhancing lesion from intrinsic T1WI hyperintensity due to fat containing lesions. T2WI is useful for distinguishing isointense neoplasm from hyperintense obstructed sinus secretion. Fat suppression allows better contrast between tumor and sinonasal secretion. Coronal CEFS-T1WI is valuable for assessment of perineural spread through the ASB. Sagittal images allow clear delineation of the craniocaudal extension of the ASB lesions.

NORMAL ANATOMY OF THE ANTERIOR SKULL BASE

The ABS consists of the frontal bone (orbital plate), ethmoid bone (cribriform plate, lateral lamella, and fovea ethmoidalis), and sphenoid bone (planum sphenoidale and lesser wing) (**Fig. 1**). The superior surface of the orbital plate forms the lateral parts of the ASB. The planum ethmoidal and sphenoidale are posterior to the cribriform plate, forming the roof of the ethmoid and sphenoid sinuses, respectively. The planum sphenoidale leads laterally to the lesser wing of the sphenoid bone and posteriorly to the prechiasmatic groove and the tuberculum sellae. The anterior clinoid process forms the posteromedial part of the lesser wing. The posterior edge of the lesser wing is the posterior boundary of the anterior cranial fossa.

The crista galli is a bony protuberance in the midline of the cribriform plate. The foramen cecum is between the frontal bone anteriorly and the crista galli posteriorly, and has a variable size. It transmits emissary veins from the nasal mucosa

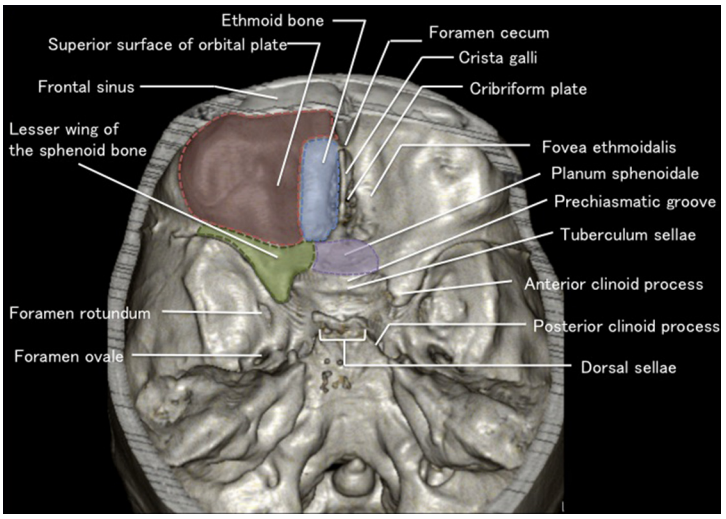

Fig. 1. Anatomy of the anterior skull base. Volume rendering CT image of the skull base demonstrates an overview of the anterior cranial fossa.