Advances in Imaging of the Pediatric Pituitary Gland

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KEYWORDS

• Pituitary • Sella • Pediatric • Imaging • Advanced imaging

KEY POINTS

- Conventional MRI of the pediatric sella is a readily available and reliable method to characterize size and configuration of the pediatric pituitary.
- Dynamic contrast imaging through the sella, and high resolution sections, can enhance definition of the gland and identify small lesions that might have gone undetected previously.
- Because developmental abnormalities of the gland are commonly associated with other brain defects, particularly in the midline, at least gross brain survey is typically obtained at the same session.
- Advanced imaging techniques, such as elastography, perfusion, spectroscopy, and diffusion imaging, may further enhance yield of sellar imaging.

INTRODUCTION

The pathology of the sella turcica differs by age at presentation; however, imaging techniques tend to be similar across different age groups. This article reviews the current standard imaging of the sella, followed by many state-of-the-art imaging techniques that are being refined before widespread clinical use. Many of the detailed imaging parameters and techniques are more thoroughly covered in neuroradiology articles and textbooks, some of which are cited. This article is intended to act as a bridge between the clinician and radiologist, and to give an overview of emerging techniques and anticipated developments in age-appropriate imaging of the sella.

Computed Tomography

MRI has replaced computed tomography (CT) as the modality of choice in evaluating the pituitary gland due to its superior depiction of soft tissue contrast. There are, however, a few advantages of CT including its superior spatial resolution, accurate

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detection of calcification and bone destruction, and mapping of the relevant bony anatomy in advance of surgery. Consideration of radiation dose remains one of the major limitations of CT, especially in the pediatric population. CT imaging of the sella is also degraded due to "beam hardening" artifact from the adjacent sphenoid bone, in which absorption of lower-energy e-ray photons by bone results in fewer photons ultimately striking the x-ray detectors. Still, newer CT technology, such as dual-energy and dynamic contrast-enhanced multisection CT, have been shown to be useful in differentiating pituitary adenomas from other parasellar lesions, as well as in the detection of occult functional microadenomas.[1,2] Although these CT-based techniques may prove to be useful in diagnostically challenging cases, radiation dose becomes more pertinent in these multiphase imaging regimens. In summary, aside from bone definition, CT is typically used to image the sella only when an MRI cannot be obtained due to medical contraindication, such as cochlear implant or pacemaker or patient habitus, conditions albeit uncommon in the pediatric population.

MRI

MRI sequences for imaging of the sella may vary significantly by institution, and the ultimate choice of sequences will depend on the specific scanner hardware, field strength, and even radiologist preference. In general, scans will be obtained to survey the gland and surrounding tissue adequately, with coverage in at least 2 planes. A sample imaging protocol might include sagittal and coronal T1-weighted and T2-weighted sequences, as well as gadolinium-enhanced sagittal and coronal T1-weighted sequences. Because sellar structures are so small, and intrinsic lesions even smaller, it is imperative to obtain small field-of-view (FOV) images with each section thin enough to limit the effects of partial volume averaging, a condition in which 2 adjacent structures cannot be clearly resolved because they lie within the same slice. Traditional imaging at 1.5 T has used 2-mm or 3-mm scan thickness with little or no gap (10% or less) between sections. With advances in scanner technology, and with the growing popularity and prevalence of 3 T scanners, many centers now obtain 1.0-mm to 1.5-mm sections or even volumetric scans to assess the sella, which afford submillimeter spacing and reformatting in virtually any plane without significant reconstruction artifact. Such optimized resolution is crucial in assessing microadenomas that may escape detection on the thicker sections (**Fig. 1**).

In addition to high-resolution sellar imaging, many will also obtain one or more survey sequences of the entire brain, as sellar abnormalities (especially in the pediatric population) may be associated with other genetic and developmental findings. Description of these entities is beyond the scope of this article, but associated entities of septo-optic dysplasia (de Morsier syndrome), holoprosencephaly, Kallmann syndrome, CHARGE syndrome, and others are described in dedicated review articles.[3–5]

Some pituitary abnormalities, most notably microadenomas, are most reliably seen using T1-weighted sequences obtained with gadolinium chelate administration. Gadolinium is a lanthanide element that has 7 unpaired electrons, bestowing on it paramagnetic properties.[6] This atom shortens the so-called T1 and T2 relaxation times of water. As a result, gadolinium that remains in the blood pool, and especially contrast that extravasates from the blood pool through a damaged blood-brain barrier, causes the containing structure to appear bright, or hyperintense. This property distinguishes enhancing tissues from nonenhancing tissues.

Although free gadolinium is highly toxic to humans, when gadolinium is chelated to specific ligands it has a very favorable safety profile. Ligands in clinical use include such agents as diethylenetriaminepenta-acetic acid (DTPA), which bind strongly to the gadolinium ion thereby minimizing release of free gadolinium into serum. Until