Magnetic Resonance Imaging of Pituitary Tumors

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Magnetic Resonance Imaging (MRI) is currently considered a major keystone of the diagnosis of diseases of the hypothalamic-hypophyseal region. However, the relatively small size of the pituitary gland, its location deep at the skull base and the numerous physiological variants present in this area impede the precise assessment of the anatomical structures and, particularly, of the pituitary gland itself. The diagnosis of the often tiny lesions of this region – such as pituitary microadenomas – is then difficult if the MRI technology is not optimized and if potential artifacts and traps are not recognized. Advanced MRI technology can not only depict small lesions with greater reliability, but also help in the differential diagnosis of large tumors. In these, defining the presence or absence of invasion is a particularly important task. This review describes and illustrates the radiological diagnosis of the different tumors of the sellar region, from the common prolactinomas, nonfunctioning adenomas and Rathke’s cleft cysts, to the less frequent and more difficult to detect corticotroph pituitary adenomas in Cushing’s disease, and other neoplastic and nonneoplastic entities. Finally, some hints are given to facilitate the differential diagnosis of sellar lesions.

Pituitary adenomas represent the most common pathology of the sellar region. They become symptomatic if they exert a mass effect on the surrounding structures, or in cases of hormonal hypersecretion. Pituitary adenomas are frequently discovered by chance. The majority of this chapter will be devoted to the diagnosis of pituitary adenomas with magnetic resonance imaging (MRI). Most recent aspects will be particularly emphasized. Other tumors of the sellar region will be discussed more briefly at the end of the review.

MRI has totally supplanted CT (computed tomography) in the diagnosis of these lesions. The role of advanced techniques, such as high-field 3-tesla MRI, dynamic contrast-enhanced MRI, diffusion-weighted MRI and apparent diffusion coefficient (ADC) maps, spectroscopy or arterial spin-labeled perfusion imaging will be discussed. CT is still obtained in rare cases, including the search for tumor calcifications when a craniopharyngioma is suspected, or of bone erosion in the presurgical assessment of the clivus in aggressive pituitary adenomas.

The Normal Pituitary Gland

The pituitary gland is routinely examined in sagittal and coronal projections in every case, and in axial projections in some particular circumstances. In our practice, gadolinium...
injection is not always mandatory and depends on the results of nonenhanced sequences. Coronal T1- and T2-weighted sequences are always performed perpendicularly to a reference plan drawn on the sagittal view, e.g. a line tangential to the inferior surface of the corpus callosum [1] (fig. 1). This strategy permits a perfect comparison of images on serial MRIs. In normal subjects, the shape of the anterior pituitary is variable on coronal images, with a flat, concave or convex upper surface; its height can vary considerably from 1–2 to 7–8 mm. The T1-weighted signal of the normal anterior pituitary gland is strictly identical to that of the cerebral white matter, and this accurate relationship is very useful in clinical practice. The posterior lobe can be masked by the dorsum sellae in the T1-weighted sagittal view, so that its demonstration is best obtained on axial T1-weighted fat-saturated sequences. After intravenous gado-

Fig. 1. Sagittal T1-weighted image obtained to determine coronal projections. Coronal sequences are obtained perpendicularly to the subcallosal plane.

Fig. 2. MRI of the normal pituitary gland. a, b Coronal T1- and T2-weighted images. c Axial T1-weighted fat-saturated image (the arrow points to the posterior lobe). d Sagittal T1-weighted image: anterior pituitary (1); posterior pituitary (2); pituitary stalk (3); 3rd ventricle (4). e Contrast-enhanced sagittal T1-weighted MRI: enhancement of the anterior pituitary, the pituitary stalk and the tuber cinereum (arrow). f Anatomic representation of the normal sellar region; reproduced with permission from Köpf-Maier [41].
linium injection, enhancement of the anterior pituitary, pituitary stalk and tuber cinereum is normally observed [1] (fig. 2).

Pituitary Adenomas

The MRI aspect of pituitary adenomas is herein described according to their size and their hormonal secretion. Some particular conditions are separately mentioned.

Pituitary Microadenomas

Pituitary microadenomas are defined as tumors measuring less than 10 mm in diameter. They are typically represented by distinct small intrasellar lesions. We have proposed the term ‘picoadenomas’ for adenomas measuring less than 3 mm that frequently need specific technical options, such as the search for corticotrophic adenomas. Traps and pitfalls are numerous [1].

Pituitary microadenomas have to be differentiated from:

- artifacts, in particular partial volume artifacts [2];
- normal anatomical structures, such as the posterior pituitary or the ‘fossula hypophyseos’ [2];
- variants from normal, such as unusual intrasellar arteries, an unusually well-developed inferior coronal sinus or a sellar spine [2];
- intrasellar cysts, such as Rathke’s cleft cysts (RCC), that are encountered very frequently [2];
- a small sella turcica can also mimic a pituitary gland enlargement; indeed, such a small sella can be flat and frequently associated with an extensive sphenoidal sinus pneumatization, short (e.g. with a thick dorsum sellae) or narrow, when the sellar floor is <10 mm in width [2] (fig. 3).

Dynamic imaging has to be read with caution and can be the source of false positive diagnoses: early normal enhancement of a posterior pituitary, laterally located within the sella, could be interpreted erroneously as a controlateral defect in enhancement of the anterior pituitary [1, 2] (fig. 4).

Microprolactinomas

Microprolactinomas are by far the most frequent pituitary microadenomas. They are usually round or oval in shape, located off midline, hypointense on T1-weighted images, as compared to the normal anterior pituitary gland, and more or less hyperintense on T2-weighted images. Microprolactinomas generally have a T1-weighted signal similar to the cerebral gray matter, while the normal unaffected anterior pituitary gland has the same T1-weighted signal as the cerebral white matter [1] (fig. 5). High signal intensity on T1-weighted images can sometimes be observed, reflecting hemorrhagic transformation, not uncommon even in asymptomatic patients with prolactinomas [3]. Intratumoral calcifications are very rare, but do not rule out the diagnosis of pituitary adenomas, particularly in men. An additional CT scan can be helpful in these cases [1, 2].

There is probably some relationship between the tumor T2 signal and the serum prolactin levels; in our experience, the more hyperintense the tumor, the lower the prolactin levels are. T2 hypointense microprolactinomas are very unusual; they seem to be associated with higher prolactin levels and can possibly have a different evolution, e.g. arise during pregnancy [4] (fig. 6, 7).

There is generally a good correlation between the prolactin level and adenoma size, except for extremely T2-hyperintense and T1-hyperintense lesions as these situations usually correspond to tumors secreting low amounts of prolactin.

Fig. 3. a, b Small sella, short sellar floor and hyperpneumatization of the sphenoid bone (frontal view).
We have almost never detected a microprolactinoma with a prolactin level <1,000 mIU/l (35 μg/l) on MRI.

Indirect radiological signs of a microadenoma are changes of the sellar floor and an upper convex surface. The pituitary stalk displacement is not always helpful for diagnosis. However, a localized subtle deformation of the sellar floor is a valuable indicator, even for small microadenomas [1].

When the radiological diagnosis is obvious after T2- and T1-weighted sequences in a context of infertility, amenorrhea-galactorrhea and hyperprolactinemia, we consider contrast-enhanced sequences unnecessary. On the contrary, contrast medium injection must be used in all uncertain situations, e.g. if an isointense or hypointense pituitary microadenoma is suspected [1].