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Eye On Imaging

Pituitary Adenomas: The Entity and The Imaging

Pituitary adenoma is the most common intracranial tumor and accounts for 10-15% of all primary neoplasms. With rare exception, they are WHO grade I. Adenocarcinomas of the pituitary are exceedingly rare.

There are two categories of primary pituitary tumors--microadenomas and macroadenomas. The definition is based on size; microadenomas are tumors less than 10mm and macroadenomas are over 10 millimeters. While this definition seems somewhat arbitrary, the tumors, in general, are two different entities by imaging criteria and on clinical presentation. However, overlap exists. Sixty percent of primary pituitary tumors are macroadenomas, 40% are microadenomas.

Microadenomas:
Patients who are referred for pituitary imaging often have symptoms suggesting abnormal hormone secretion. The most common clinical presentation is a female with primary or secondary amenorrhea, infertility or galactorrhea. Prolactinomas are the most common hormone secreting tumor of the pituitary. In general males with prolactinomas are asymptomatic but can present with loss of libido and impotence. Other hormones secreted by tumors of the adenohypophysis include growth hormone, adrenocorticotrophic hormone (ACTH), thyroid stimulation hormone (TSH), and gonadotrophes (LS, FSH). The most clinically significant are ACTH tumors, which result in Cushing's disease. Children and adolescents who have growth hormone excess present with gigantism, while adults present with acromegaly. The TSH, LH and FSH tumors are very uncommon and present with clinical pictures appropriate to the hormone secreted.

Imaging:

The modality of choice is gadolinium-enhanced MRI. Newer scanners have made possible the implementation of high-resolution dynamic imaging of the pituitary. In general, the study is dedicated to the gland using slice thickness of less than one millimeter. Additionally larger field of view images are also obtained at 3 mm to encompass surrounding structures such as the cavernous sinus, optic chiasm and hypothalamus.

The pituitary is imaged in both the sagittal and coronal planes. The key to identifying adenomas is the use of pre- and post-contrast images using T1-weighting; dynamic scans are sequentially repeated over time during the infusion of gadolinium using rapid scanning and sub-millimeter slice thickness.

Before contrast, adenomas may have different "signal" than normal pituitary tissue, but are frequently indistinguishable from the gland. Post-contrast images, however, typically show a lesion with no enhancement on early phases with increasing uptake of gadolinium on later acquisitions (Fig. 1). Detection of adenomas is 90% sensitive using this technique for MRI imaging. Without the utilization of high-resolution, dynamic imaging up to 30% of adenomas are missed.

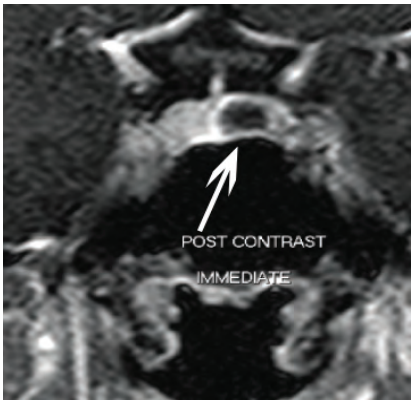

Figure 1: High resolution post-contrast imaging, in the early phase, exquisitely demonstrates the microadenoma. Notice slight deviation of the infundibulum away from the tumor. (Coronal image)

Microadenomas are located in the anterior pituitary (adenohypophysis); the posterior pituitary (neurohypophysis) is unaffected. The lesions are well circumscribed and are usually laterally located in the gland (Fig. 1). Adenomas have a round appearance, and do not appear infiltrative.

In patients who cannot undergo MR examinations, high-resolution CT scanning with and without contrast is performed. Dynamic, contrast-enhanced scanning can also be obtained with a multi-slice CT, obtaining sub-millimeter images. CT, however, is limited, as the inherent tissue contrast is not that of MRI. In addition, the adjacent bony sella causes artifact that interferes with identifying adenomas. Sensitivity is limited to approximately 60% of tumors.

Microadenomas can be seen as incidental findings on routine brain imaging. Of those that are incidentally discovered, 25% are non-functioning. Follow-up with blood hormone levels in these patients confirms either a functioning or non-functioning tumor. Estimates from autopsy studies suggest that 3% of the population has a microadenoma.

Differential considerations of a less than 10millimeter lesion of the sella include Rathke's cleft cyst (most common), normal pars intermedia, intra-pituitary craniopharyngioma (incredibly rare), and pituitary hyperplasia. Imaging of pituitary hyperplasia, demonstrates generalized enlargement of the gland, but with no discrete lesion. Rathke's cysts and pars intermedia do not have early or delayed enhancement, are centrally located and are separate from the normal gland (Fig. 2). The clinical findings in the above entities are important to consider; blood hormone levels are normal or decreased from pituitary compression.

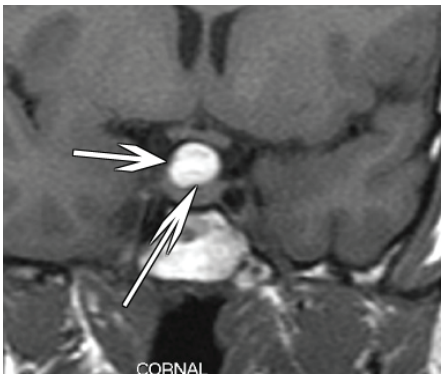

Figure 2: Rathke's cyst (top arrow) "sits" above the compressed pituitary (lower arrow). The cyst is "white" from proteinaceous content. (Coronal img.)

BIOGRAPHY

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Dr. Rachael Gordon graduated with honors from University of Colorado Medical School. While there, she was elected to Alpha Omega Alpha Honor Society. Following her diagnostic radiology residency at Cedars-Sinai Medical Center, Dr. Gordon completed at two-year fellowship in Neuroradiology at the Mallinckrodt Institute of Radiology at Washington University in St. Louis. Dr. Gordon obtained her Certificate of Added Qualification in Neuroradiology from the American Board of Radiology and is a senior member of the American Society of Neuroradiology. She has been practicing neuroradiology in Los Angeles for since 1997.

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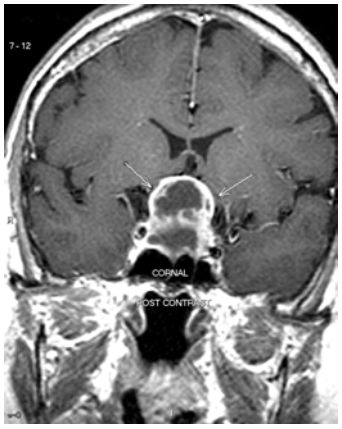

Figure 3: Post-contrast images of a macroadenoma with classic "snowman" configuration. The optic chiasm is compressed and it is not visible. The tumor has cystic areas that do not enhance. (Coronal image)

Macroadenomas:
Macroadenomas, because of their size, are inseparable from the normal glandular tissue; in contradistinction, microadenomas are seen as distinct tumors within the pituitary. On both MRI and CT, the tumors classically have a "snowman" morphology with a lobulated contour; the tumors grow into the supra-sellar cistern, but are constricted by the diaphragm of the sella (Fig. 3). There is frequently compression of the optic chiasm and invasion of the cavernous sinus. If the adenoma reaches over 4 centimeters, it is termed a "giant" adenoma; these tumors, although histologically benign, invade the adjacent clivus, cavernous sinus, and brain (Fig. 4).

The clinical presentation is related to excessive hormone secretion, if the tumor is functioning. As in microadenomas, prolactinomas are the most common tumor, with levels of prolactin that can exceed 1,000 ng/ml in giant adenomas. Other hormonally secreting tumors have appropriate clinical symptomatology.

When the tumor is non-functioning, it is able to grow undetected until patients present with bitemporal hemianopsia (optic nerve compression), headaches, and/or with symptoms related to invasion of the cavernous sinus with cranial nerve dysfunction. Seventy-five percent are functioning, with the other 25% presenting with symptoms related to involvement of adjacent structures.

Figure 4: Post-contrast coronal image of a giant adenoma, notice the lobulated "snowman" configuration. The carotid arteries are engulfed by the mass, but are widely patent showing flow (black circles).

Imaging:

Contrast-enhanced MRI is the modality of choice. There is exquisite definition of the adenoma and invasion of adjacent structures. Macroadenomas completely replace the normal gland, and the infindibulum is not separable from the lesion. MRI demonstrates the optic nerve compression and involvement of the cavernous sinus. With giant adenomas, invasion of the clivus and growth into sphenoid sinus are almost always present (Fig. 4). On non-contrast imaging the tumors are variable in signal; with contrast, tumors avidly enhance. Intra-tumoral hemorrhage, cyst formation and necrosis are not uncommon (Fig. 3). Even in the presence of extensive cavernous sinus invasion, the carotid arterives, while encased, are not compressed. The flow within the arteries is seen as black "voids" in the tumor (Fig. 4). This finding is useful when differentiating an adenoma from other lesions such as metastatic disease.

CT scans are used in patients who cannot undergo MRI, but also as an adjunct to MRI. CT has the advantage of showing expansion of the dorsum sella and erosion of the clivus, which is important in operative planning.

Differential diagnosis of supra-sellar/para-sellar lesions includes meningiomas, craniopharyngiomas, aneurysms, metastatic disease, lymphocytic hypophysitis and pituitary hyperplasia (Fig. 5). Macroadenomas are exceedingly rare in children; an enlarged gland in children warrants testing for end-organ failure.

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Figure 5: Post–contrast coronal images of a meningioma, invasive into the sella. While the lesion has a "snowman"(1) configuration, the MRI defines a normal, compressed gland(2) and dural tail(3), making the diagnosis of a meningioma.

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