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Pituitary gland imaging - review of the literature

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Abstract
Introduction: is an endocrine gland located upon the hypophysial fossa of the sphenoid bone in the center of the middle cranial fossa and is surrounded by a small bony cavity (sella turcica).
Radiological procedures are playing essential role in present diagnostic of pituitary gland.
Pituitary tumours can now be visualized more accurately due to continued improvements in magnetic resonance imaging (MRI) techniques with gadolinium enhancement.
Aim of the study: This article summarizes the current knowledge about radiological imaging of pituitary gland and in particular MRI scan procedures. In this paper we also want to show how the imaging of the pituitary gland looked like in the past and nowadays.

Description of knowledge: Diagnostic procedures play primary role in present diagnosis and treatment of pituitary gland and sella turcica tumours. It is crucial for further diagnostic procedures to locate the tumour its size and margins. Currently magnetic resonance imaging is the more important examination just after the laboratory results. That modality easily shows exact location and tumours smaller than 1 cm. Radiological differentiation of lessions wouldn't be possible without contrast agents. The latest MRI study protocols involve dynamic and delayed sequences for better visualisation and differential diagnostic.
Conclusions: During the years radiological techniques evolved and gave us the perfect tool to visualize the pituitary gland and its pathologies.

Key words: pituitary gland; hypophysis; sella turcica; magnetic resonance imaging; radiology.

The pituitary gland (hypophysis) is a small endocrine gland located within the sella turcica of the central skull base. Pituitary together with its connections to the hypothalamus, acts as the main endocrine interface between the central nervous system and the rest of the body. It is usually divided into anterior and posterior parts, which refers to groupings of four subparts:

- anterior pituitary

- pars distalis
- pars tuberalis
- pars intermedia

- posterior pituitary

- neurohypophysis

The anterior pituitary produces multiple hormones, including, prolactin, growth hormone (GH), adrenocorticotropic hormone (ACTH), thyroid-stimulating hormone (TSH), follicle-stimulating hormone, and luteinizing hormone. Pars distalis is the largest part of the pituitary gland. It arises from the anterior wall of Rathke pouch. It is composed of cords of epithelial cells individually specialized to secrete trophic hormones acting on various target organs. Pars tuberalis is the part of the adenohypophysis which surrounds the anterior aspect of the infundibular stalk. The pars intermedia in a thin layer of epithelial cells located between pars distalis and neurohypophysis. It arises from the posterior wall of Rathke pouch and contains vestigial lumina of Rathke pouch which appears as narrow vesicles of variable length. These may give rise to Rathke cleft cysts.
The posterior pituitary (neurohypophysis) is an anatomic extension of the hypothalamus and is the site for the secretion of oxytocin and vasopressin.
Hypophysis is surrounded by many structures. Inferiorly is in strict connection with sphenoid bone and sphenoid sinus. Superiorly it borders with many important anatomical structures like diaphragma sellae, supersellar cistern (pituitary stalk, optic chiasm, circle of Willis, hypothalamus). Laterally located to cavernous sinuses. It lies anteriorly to anterior intercavernous sinus anterior clinoid processes. Posteriorly to posterior intercavernous sinus and dorsum sellae[1].
Volume of the pituitary can be changed depending on hormonal status, it enlarges most dramatically during pregnancy and even sometimes could be mistaken for an adenoma.

The well-known size changing factor is also the age of the patient. Generally young adults and hormonally active people have larger pituitary glands than older persons.
Keep that in mind that we have to be careful while making measurement. In radiological practice we use Elster's rule which provides a guide to the expected approximate pituitary gland height in relation to age[2].
The pituitary gland has a rich blood supply because of its important role in endocrine system.

Many different radiological modalities were used to visualise pituitary gland during the years including plain radiographs, pneumoencephalography, angiography, CT and MRI.

In plain radiographs of the skull, we can only notice remodeling of the pituitary fossa, erosion of the tuberculum sellae as well as outlining tumoral calcification or hyperostosis
It is, however, incapable of visualizing suprasellar extension of disease.

Computed tomography (CT) was a revolutionary technique that could scan very fast all parts of the body, but especially the central nervous system. In routine CT it`s possible to detect changes in the pituitary fossa, however, it was the development of true coronal technique and dynamic scanning which, for the first time, was able to directly visualize microadenomas.
The development of intravenous contrast agents allowed microadenomas to be seen as areas of delayed enhancement. CT is currently reserved for the assessment of bone destruction and surgically relevant bone anatomy.

Pneumoencephalography was performed by injecting air into the subarachnoid space and maneuvering it into the basal cisterns.

Plain radiography, conventional tomography and pneumoencephalography are all historical techniques, which are no longer performed in the assessment of pituitary disease.
It is also achievable to make a catheter angiography. It was used to show displacement of regional vessels thereby inferring the presence of a large mass, it is also useful in directly visualizing tumors which have altered vascularity.
Relatively new modality magnetic resonance imaging (MRI) has essentially replaced all other modalities for routine imaging of the brain and pituitary. With MRI wen can evaluate the sella and perisellar lesions with high soft tissue contrast and excellent anatomic resolution,
T1-weighted spin echo images constitute the basis of any imaging of pathology in and around the sella [3]. The MRI protocols evolved from noncontrast enhanced sequences 1980 to the introduction of thin-section contrast MRI scans in early 1990s and, more recently, the use of high magnetic field strength technology and dynamic post-contrast sequences [4].
MRI protocols can vary depending on MRI hardware and software, radiologist's and referrer's preferences, institutional protocols, patient factors. Chosen sequences are put together to improve sensitivity and specificity for the assessment of lesions of the pituitary gland.

Generally, we can assume that a typical targeted MRI examination of the pituitary region includes coronal and sagittal small field of view T1 and T1 post-contrast images, as well as dynamic contrast-enhanced coronal images, which are critical for the identification of small microadenomas. T2 weighted sequences are often also included, although are of relatively little-added benefit.

With the development of the MRI systems, experience with 3 tesla (3T) imaging has been reported [5]. The higher magnetic field allows a more detailed imaging of the anatomic structures. The acquisition time is shorter and the higher resolution in modified protocols allows for depiction of minute lesions which escape detection in standard 1.5 T images[6].

Unfortunately, the signal-to-noise ratio also increases resulting in significant artifacts being produced. For this reason, increasing the field strength even more, to 7 T, does not offer advantages for the diagnostic imaging of sellar lesions.

SPECT/PET

While discussing the current use of MRI for tumour imaging, molecular imaging is also needed to be discussed. The presence of high numbers of D2 and prolactin-secreting D2 receptors can be detected in almost everyone with hormonally active pituitary adenomas.

Different methods are used to visualize D2 receptors in the brain using photon emission computed tomography SPECT. The most commonly used method is 123I-epidepride, which is superior to 123IIBZM for its use in detecting D2 receptors on pituitary macroadenomas[12].

Due to the high cost and the poor resolution of their investigations, they are not commonly used in clinical practice. However, they are still valuable tools for research.

Having a comprehensive approach to the pituitary region imaging is very important if subtle lesions are to be detected. There is no single correct way to do this, and what is presented is merely a personal approach. In every description key structures should be identified, such as pituitary gland including posterior pituitary bright spot and infundibulum, optic nerves, chiasm, and tracts, diaphragma sellae and boundaries of the pituitary fossa, boundaries of the cavernous sinus and Meckel's cave, internal carotid arteries and branches and dynamic enhancement of the pituitary.

Before we start the examination, we have to ensure that it is age-appropriate in size and normal in signal. The infundibulum should be midline and the posterior pituitary bright spot should be sought, although it is not always visible.

The dynamic enhanced coronal images should be viewed in such a way as to view the wash in of contrast at each location.

The optic nerves, optic chiasm, and optic tracts should be carefully assessed as even small lesions can lead to visual symptoms, which are a common indication for imaging of this area.

Extreme care should be taken in ensuring that there are no compressive lesions such as a 2-3 mm meningioma. The optic nerves should be followed as far anteriorly as possible on coronal T2 images assess for the presence of increased signal within the nerve.

Following this, the boundaries of fossa should be examined to ensure that the fossa is not enlarged or eroded (previous mass, hydrocephalus, intracranial hypertension). At this time, the bone marrow signal in the clivus should be assessed.

The cavernous sinuses and Meckel's caves should be examined for symmetry and normal anatomy. The visible arteries should all be inspected for obvious aneurysms or malformations; this is best done on T2 weighted imaging if provided. Although no dedicated arterial imaging is present, finding an asymptomatic aneurysm can be a life-saving event. In contrast, missing an obvious aneurysm which later ruptures is a tragedy. Particularly relevant regional aneurysms include anterior communicating artery aneurysms, medially projecting "carotid cave" aneurysm, superiorly projecting ophthalmic artery aneurysms, terminal internal carotid artery aneurysms, posterior communicating artery aneurysms and basilar tip aneurysms.

In MRI study we have to always be careful and check if there's an aberrant course of the carotid or other aberrant vessels, especially if surgery is likely.

It is also important that the rest of the examined brain should be reviewed for other findings like pathological masses.

Aside from a general description of a pituitary mass there are a number of other features that should also be noted upon in order to aid in the decision-making process.

In this description we have to define the mass size in three dimensions, if there is any presence of necrotic or cystic areas. The size of diaphragmatic opening and suprastellar component. Also describe presence of prolapse of the suprasellar membrane, of invasion into the cavernous sinus/clivus/sphenoid sinus/orbit, vessels and bony structures of the sella [13,14].

The most common primary lesion of the pituitary gland, sella, and suprasellar region is the adenoma. However, the spectrum of nonadenomatous abnormalities is broad, and a reasonable differential should be considered for each lesion. For most cases, the location, point of origin, and clinical scenario of a lesion are important factors that can be utilized to propose the most appropriate diagnosis. Nowadays the imaging procedure of choice for the pituitary gland is a targeted MRI examination which has largely replaced CT. CT is currently reserved for the assessment of bone destruction and surgically relevant bone anatomy. Other imaging methods presented in this article are no longer used in clinical practice. MRI examination should be performed with precision and special care because only if we improve image quality it will lead us to more accurate diagnosis.

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