Noninvasive parathyroid imaging in primary hyperparathyroidism

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Riassunto

IMAGING NON INVASIVO NELL'IPERPARATIROIDISMO PRIMITIVO

Molti studi hanno dimostrato che la localizzazione preoperatoria delle ghiandole paratiroidee patologiche in corso di iperparatiroidismo primario è in grado di ridurre i tempi operatori, soprattutto in caso di paratiroidi ectopiche.
Attualmente le tecniche di imaging non invasive usate per la valutazione dei pazienti con iperparatiroidismo primario includono la scintigrafia con ^{99m}Tc-sestamibi, l'ecografia ad alta risoluzione del collo e l'esplorazione con la TC e con la risonanza magnetica.
La sensibilità ed il valore predittivo positivo variano per ciascuna tecnica tra il 70% ed il 90%; la combinazione di due o più tecniche può significativamente migliorare tali risultati.
Nell'era della chirurgia mininvasiva, la paratiroidectomia mininvasiva radioguidata e videoassistita necessitano di un'accurata localizzazione preoperatoria delle paratiroidi patologiche; tale localizzazione dovrebbe essere ottenuta nei pazienti con iperparatiroidismo primario prima dell'intervento al fine di ridurre la durata dell'intervento stesso e della degenza postoperatoria del paziente.
Parole chiave: Iperparatiroidismo primario, ecografia, scintigrafia.

Abstract

Several studies suggested that preoperative localization of abnormal parathyroid (PT) glands may be useful in reducing operative time facilitating parathyroidectomy, especially in patients with ectopic PT glands. At present, noninvasive techniques used to evaluate patients with primary HPT include (1) 99mTc-sestamibi scintigraphy, (2) high-resolution neck ultrasonography, (3) CT scanning, and (4) magnetic resonance imaging (MRI). The sensitivity and positive predictive value of each technique range from 70% to 90%, and a combination of two of more tests may significantly improve the results. In the minimally-invasive era both radioguided and videoassisted parathyroidectomy require an accurate preoperative localization of the abnormal PT glands, and PT imaging should be obtained before surgery in all patients with primary hyperparathyroidism, with the aim of reducing operative time and hospital stay.
Key words: Primary hyperparathyroidism, ultrasonography, scintigraphy.

Introduction

Primary hypeerparathyroidism (HPT) is a common disease. In the USA one in every 500 women and one in every 1,000 men over 40 years may have primary HPT (1).
Several studies suggested that preoperative localization of abnormal parathyroid (PT) glands may be useful in reducing operative time facilitating parathyroidectomy, especially in patients with ectopic PT glands (2-6). Moreover, since primary HPT is caused by a solitary PT adenoma in 85% to 90% of cases, unilateral and minimally-invasive parathyroidectomy has become to be extensively performed, and subsequently both the sensitivity and specificity of localizing techniques has increased.
At present, noninvasive techniques used to evaluate patients with primary HPT include (1) ^{99m}Tc-sestamibi scintigraphy (SS), (2) high-resolution neck ultrasonography (US), (3) computed tomography (CT) scanning, and (4) magnetic resonance imaging (MRI).
For patients with persistent or recurrent HPT, a combination of functional methods such as SS, and one or more anatomic methods such as US, CT-scan or MRI are used, while patients initially diagnosed with primary HPT usually undergo a single cross-sectional study (7).

Parathyroid scintigraphy

Scintigraphic techniques for the evaluation of patients with primary HPT include ^{201}Tl-chloride/^{99m}Tc-pertech-

Fig. 1: 99mTc-Sestamibi scintigraphy in a 54-year-old women with a left inferior parathyroid adenoma.

netate subtraction (dual-tracer) scintigraphy and ^{99m}Tc-sestamibi scintigraphy with ^{99m}Tc-pertechnetate subtraction, which currently represents the technique of choice as scintigraphic method for the pre-operative localization of enlarged PT glands (7). When the thyroid uptake of pertechnetate is inhibited by the recent use of iodine-containing preparations (contrast media, L-thyroxin), the subtraction technique can be substituted with double-phase (early and delayed images acquisition) ^{99m}Tc-sestamibi scintigraphy (Figure 1).
Patients are usually examined in normal supine position, using a gamma-camera fitted with a high-resolution parallel-hole collimator, centered on the neck region (5, 8). High-count images are acquired, starting approximately 10 minutes after intravenous administration of ^{99m}Tc-sestamibi (740 MBq), and ^{99m}Tc-pertechnetate (50-150 MBq). After careful inspection and correction of any patient motion, the sestamibi and pertechnetate images are summed, independently normalized, and a subtraction image (sestamibi-pertechnetate) is generated. In order to localize ectopic glands it is essential to acquire at least one sestamibi image comprising the entire mediastinum in the field-of-view. Abnormal PT tissue is defined as an area of relatively increased tracer uptake persisting after image subtraction, or a persistent mediastinal uptake (4, 5, 7). When the double phase technique is chosen, areas of increased uptake on the early images persisting on delayed (2-3 hours) scans are interpreted as abnormal PT glands, since the activity in the normal thyroid tissue washes out more rapidly (8, 9).
Both techniques offer high sensitivity and specificity, although increasing evidence suggests that the subtraction technique, even if technically more demanding, has a superior sensitivity, compared with the dual phase scan (10, 11).
The best clinical result are obtained by combining SS and US, but single-photon emission computerized tomography (SPECT) imaging and pinhole collimator use can further enhance scintigraphic diagnosis in selected cases (6). The sensitivity of SS ranges from 80% to 90% (12).

Ultrasonography

US should be performed by using a high-resolution 7.5-10 MHz real-time linear transducer, keeping the patient supine with the neck extended (13, 6). US gives an image of the entire neck, from the submandibular glands to the subclavian vein, using the thyroid gland as a reference point (14). However, US is unable to visualize retro-esophageal and retro-tracheal PT glands, while if the probe is aimed downwards the upper mediastinum may be sometime visualized (15).
The typical sonographic appearance of a PT tumor was a hypoechoic nodule, oval or oblong in shape, posterior

Fig. 2: Neck ultrasonography showing a hypoechoic nodule near the carotid artery, consistent with a parathyroid adenoma.

or lateral to the thyroid lobe, nonhaderent to the surrounding tissues, ranging usually from 7 to 20 mm in size (5, 16). When abnormal PT glands exceed 1 cm in the greatest diameter both color and power Doppler US may reveal increased vascularity in the tissue (7). In a patients with a hypoechoic mass within the lower pole of the thyroid gland an intrathyroidal PT adenoma should be suspected (6).
The sensitivity and positive predictive value (PPV) of US is similar to that of SS, ranging from 75% to 80%, while US and SS together represents the most reliable noninvasive localization tool in patients with primary HPT (5, 12, 8, 6). Figure 2 shows the sonographic appearance of an ectopic (intrathymic) PT adenoma.

CT scan

Patients undergoing CT-scan should have the neck in slight extension, and they are scanned volumetrically, using axial thin sections at a speed of 1 slice/0.8 sec if helical CT scan is available. The upper limit of the heart represents the lower region of interest. The CT examination of the neck and upper mediastinum should be performed using 3-5 mm contiguous slices from the angles of yaw to the aortic arch, since the feet-to-head acquisition direction offers a better immobility with prolonged breath hold examination time (15). A bolus of nonionic contrast medium intravenous administration (80-100 ml) is used, and imaging is initiated 40-50 seconds after the beginning of the contrast injection (17). Due to their rich vascularity, abnormal PT glands enhance intensely after contrast administration, appearing on CT scan as nodules with the same density as muscles, well contrasted in comparison with the thyroid gland and mediastinal fat (15, 7). The CT diagnosis of abnormal PT glands requires identification of a bean shaped enhancing lesion, nonhaderent to the surrounding tissues, with an average size of 15-20 mm, usually sited posteriorly to the thyroid gland (18, 7). The typical CT appearance of a PT adenoma is shown in Figure 3.

MR imaging

In patients with primary HPT axial, coronal, and sagittal images 3 to 5 mm thick using T1- and T2-weighted should be obtained, with optional use of gadolinium and fat suppression technique (18). A cervical surface coil and a body coil are used with the aim of study both the neck and mediastinum (15). Enlarged and hyperfunctioning PT glands give the same signal as the thyroid gland in T1-weighted images, but mediastinal PT glands may easily be distinguished from the fat. In some studies, MRI represents the modality of choice for evaluation of ectopic PT adenomas, although its sensitivity is lower than that of CT scan (18). The most common appearance of a PT adenoma on MRI is isointense-to-low signal intensity on T1-weighted, and high signal intensity on T2-weighted images (7). In figure 4 is reported e PT adenoma detected by neck MRI.

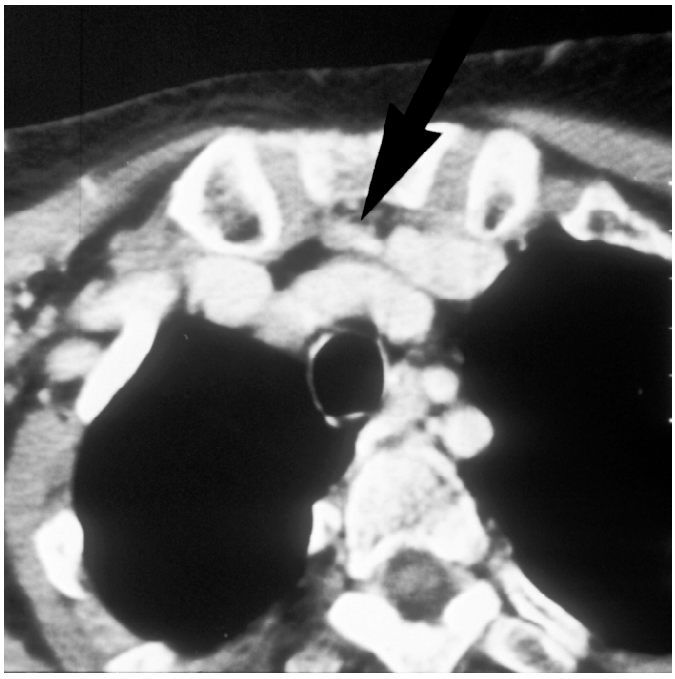

Fig. 3: CT scan image of a mediastinal parathyroid adenoma.

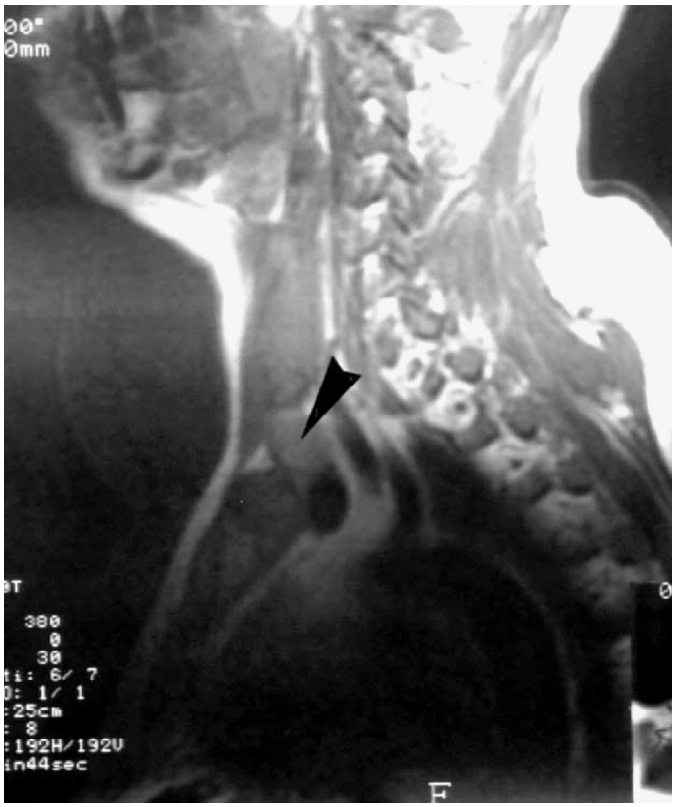

Fig. 4: MRI image of a cervical parathyroid adenoma.

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