Ultrasound of thyroid, parathyroid glands and neck lymph nodes

Abstract In the past 15 years high-frequency B-mode sonography and colour–power Doppler have become the most important and most widely employed imaging modalities for the study of the thyroid gland, in particular for thyroid gland, parathyroid and lymph nodes. Sonography allows not only the detection but often also the characterization of the diseases of these organs, distinguishing benign from malignant lesions with high sensitivity and specificity, which could be further improved by the employ of ultrasound contrast agents and harmonic imaging. Although no single sonographic criterion is specific for benign or malignant nature of the lesions, the combination of different signs can be markedly helpful to speed up the diagnostic process. Fine-needle aspiration biopsy (FNAB) remains the most accurate modality for the definitive assessment of thyroid gland nodules and of any doubtful case of nodal disease. In association with clinical findings and serum levels of parathormone, FNAB has specificity close to 100 % for the characterization of parathyroid adenomas. A combined approach with sonography and FNAB is generally highly effective.

Keywords Thyroid gland · Parathyroid glands · Lymph nodes · Ultrasnography · Power Doppler · Colour Doppler

Thyroid gland

In the past 15 years high-frequency B-mode sonography and colour-power Doppler have become the most important and most widely employed imaging modalities for the study of the thyroid gland. This is due to many reasons: the favourable anatomical location of the gland, the highest degree of vascularity (both macro- and microvascularization detectable with colour Doppler) in normal subjects among all the superficially located normal structures of the body and the extremely high incidence of thyroid abnormalities, either nodular or diffuse, most of which are benign diseases requiring periodical sonographic follow-up.

When the thyroid gland is approached with sonography, the first relevant parameter to study is the size of the gland, which is not always easily assessable with palpation due to, for example, physical limitations and surgical scars. The size of the normal thyroid gland varies according to the morphotype of subjects, reaching 7–8 cm in length with only 0.7–1.0 cm as thickness in thin subjects, whereas in obese patients the length is usually less than 5 cm, but the normal anteroposterior diameter can reach 2 cm. Being volumetric studies of thyroid lobes easily performable only with 3D ultrasound (not yet widely available), thus far thickness is considered the simplest among the most reliable indexes of thyroid size: when it is larger than 2 cm, enlargement can be confidently diagnosed [1, 2, 3].

The normal thyroid parenchyma has a characteristically homogeneous ultrasound appearance which is more echogenic than the adjacent strap muscle and well distinguishable from the many relevant adjacent structures, i.e. trachea, esophagus, nerves, large blood vessels.
in countries (like most southern European countries) with high prevalence of thyroid goitrous disease sonography is capable of detecting small, non-palpable thyroid nodules (benign in over 90% of cases) in a large amount of the population, in order to speed up the diagnostic work-up, sonographic criteria have to be employed to select the suspected lesions to undergo fine-needle aspiration biopsy (FNAB) [7]. On the contrary, in countries such as those of North America where thyroid goiter is generally sporadic, free-hand FNAB is usually performed as first assessment after the detection of a palpable thyroid nodule and sonography is performed only when FNAB is not diagnostic or when a preoperative map of the thyroid gland is needed [8].

Nodular diseases

In the investigation of thyroid nodular diseases, sonography has five major applications:

1. Detection of thyroid nodules
2. Differentiation of hyperplasia/goiter from all other thyroid nodular diseases
3. Preoperative determination of the extent of known thyroid malignancy
4. Detection of residual, recurrent or metastatic carcinoma
5. Guidance to FNAB for non-palpable nodules

As for detection and characterization, each thyroid nodule has to be studied paying attention to its level of echogenicity compared with the normal parenchyma, the presence of calcifications or cystic changes, the pattern of margins, the presence of peripheral echo-poor “halo” and the amount and distribution of blood supply [3, 9, 10, 11].

Hyperplasia is the most common pathology of thyroid gland, accounting for 80–85% of all thyroid nodules, and is more common in women [12]. It may be familial, due to iodine deficiency, to compensatory hyper trophy or secondary to hypoplasia of one lobe or partial thyroidectomy. When single or multiple hyperplastic nodules lead to a global enlargement of the gland, the term goiter (either single or multinodular) is properly used. Patients with hyperplasia/goiter are frequently asymptomatic but may occasionally present with compressive symptoms or rapidly enlarging mass, usually indicating spontaneous haemorrhagic changes within the nodule(s). Hyperplasia may have a diffuse or nodular pattern. Diffuse hyperplasia results in the enlargement of one or both lobes, with lateral or posterior deviation of the great vessels and/or the trachea, but never with infiltration of their walls. Mono- or multinodular hyperplasia is usually seen as single or multiple discrete nodules, varying greatly in number and size, separated

Thyroid pathologies are classifiable into two groups, nodular and diffuse diseases.

All thyroid diffuse diseases (with the exception of the extremely rare diffuse primary lymphoma) and approximately 90–92% of nodular pathologies are benign [4]. Actually, thyroid cancer is rare, accounting for less than 1% of all malignant neoplasms [5]. Sonography is significantly more sensitive than clinical palpation in identifying thyroid nodules [6] and in detecting multinodularity when single nodules are clinically diagnosed. Studies comparing clinical palpation with thyroid imaging show a prevalence of 13–50% for the detection of thyroid incidentalomas [7, 8]. In recent years, high-resolution sonography has confirmed the pathological statement that multinodularity does not necessarily mean benign disease or does not exclude malignancy (Fig. 1) [4, 6], being the rare thyroid malignancies often found in association with one or more benign nodules, both in the same and in the opposite thyroid lobe. Since

![Fig. 1 a, b Multinodularity does not exclude malignancy. a Multiple nodules with different echogenicity (isoechoic, mixed, cystic with dense fluid) in benign goiter. b Two contiguous hypoechoic nodules with microcalcifications and irregular margins: multifocal papillary carcinoma](image)