

Preoperative ultrasound study of differentiated thyroid cancer: relevant aspects for its optimal performance. Pictorial essay.

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Abstract

Differentiated thyroid cancer has an increasing incidence in recent years, but its mortality remains low. In this context, a preoperative ultrasound study is fundamental; it makes a difference due to its ability to adequately characterize local involvement, the presence of extrathyroidal extension and lymphatic metastases. A preoperative study can help to decide the best therapeutic measures and thus avoid adding greater morbidity to patients. In this article we present the relevant aspects to consider in the preoperative ultrasound evaluation of differentiated thyroid cancer and representative images of the main findings that can be found.

Keywords: cancer; thyroid; ultrasound; metastasis; lymph nodes

Introduction

The incidence of thyroid cancer has increased in last years, the differentiated thyroid carcinoma (DTC) being the most frequent type. Up to 95% of DTC are papillary thyroid carcinoma (PTC) [1]. Dissemination to regional lymph nodes is present in 30-80% of cases, mainly at cervical level VI (fig 1) [2,3], being the greatest risk factor for thyroid cancer recurrence, suggesting that many of the lymphatic metastases detected in the first post-treatment years are residual disease [4]. Due to the greater risk of complications related to the surgical reintervention, the interest for more accurate preoperative studies has increased, cervical ultrasound (US) being the most sensitive study, modifying the surgical approach in up to 23% of cases [4].

In this pictorial essay we present relevant aspects in the preoperative US evaluation of DTC and representative images from our experience.

Ultrasound technique

A multi-frequency linear transducer (8-15 MHz) is preferable for the correct evaluation of the deep paratracheal areas and the tracheoesophageal grooves (TEG), which are references for the trajectory of the recurrent laryngeal nerves (fig 2) [5].

The neck must be hyperextended. The patient should be asked to turn their neck to the right or left to facilitate the study of level VI lymph nodes and better expose the TEG (fig 3) [5].

The cervical region must be explored from the chin to the suprasternal region, looking for remnants of the thyroglossal duct, which are frequently close to the hyoid bone (fig 4), presence of pyramidal lobes and intrathoracic extension [5].

Characterization of thyroid lesions

Although the aim of this work is not to review the features of thyroid nodules to allocate risk of malignancy, it must be remembered that the nodules at greatest

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risk of malignancy are solid, hypoechogenic, taller than it is wide, with irregular edges, microcalcifications, intermittent ring-shaped calcifications and with extrathyroidal extension (ETE) [6].

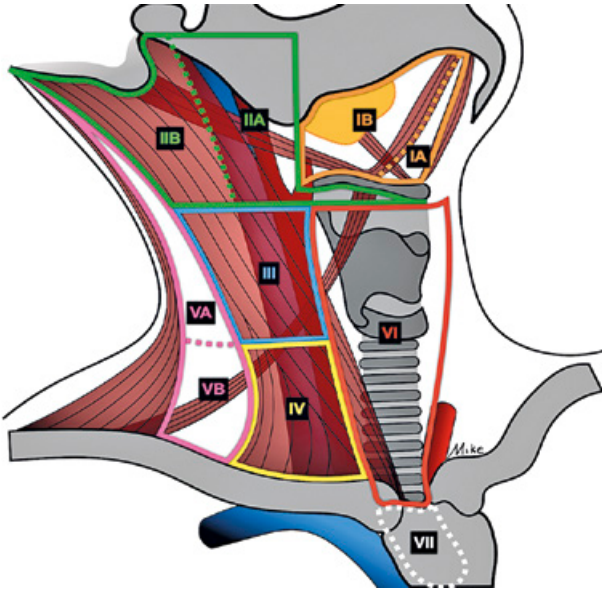


Fig 1. Neck lymph node levels. Level I: submental (IA) and submandibular (IB). Level II: upper internal jugular chain. Level III: middle internal jugular chain. Level IV: lower internal jugular chain. Level V: posterior triangle. Level VI: central (anterior) compartment. Level VII: superior mediastinal nodes. Sublevel IA and IB are separated by anterior bellies of both digastric muscles, level I and II by the vertical plane defined by the posterior border of the submandibular gland, sublevel IIA and IIB by the posterior border of the internal jugular vein, level II and III by the horizontal plane defined by the inferior border of the hyoid bone, level III and IV by the horizontal plane defined by the inferior border of the cricoid cartilage as well as sublevel VA and VB, level VI and levels III-IV by the medial borders of both common carotid arteries, and level VI and VII by superior border of manubrium.

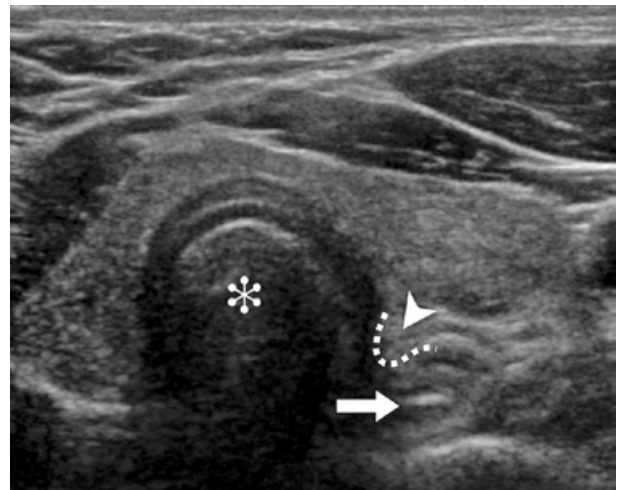


Fig 2. Left tracheoesophageal groove (dotted lines) between the trachea (asterisk) and the esophagus (arrow), through which the recurrent laryngeal nerve passes together with echogenic fatty tissue (arrowhead).

Evaluation of extrathyroidal extension

The interruption of the capsule, bulging of structures, involvement of the TEG, contact of the tumor with the capsule, and tracheal invasion suggest ETE [7,8]. Interruption of the capsule appears as a loss of the hyperechogenic interface of the capsule [8]. The protrusion of a nodule towards the TEG is associated with an invasion of the recurrent laryngeal nerve [8]. Contact between the tumor and the adjacent capsule higher than 25% of the nodule circumference have a positive predictive value of 70.7% and a specificity of 85.7% for microcarcinomas (fig 5, fig 6) [7]. The formation of an obtuse angle between the tumor and the trachea is suggestive of tracheal invasion (fig 7) [8].

It is also useful to evaluate the vocal cords and their adequate excursion; asymmetric displacement or absence of displacement of the affected side [9].

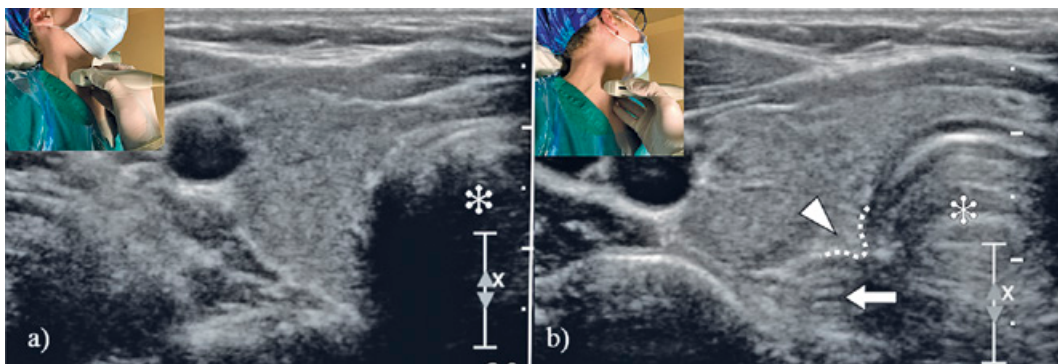


Fig 3. US that shows how to improve the visualization of the right tracheoesophageal groove (TEG) (a). Turning the head to the left (b), the esophagus slides to the right, better exposing the TEG (dotted line) and its contents (arrowhead). Asterisk: trachea.

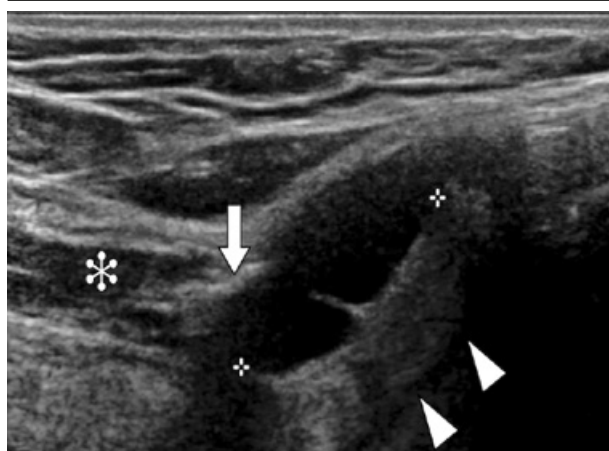


Fig 4. US in the sagittal plane, midline, demonstrating a thyroglossal duct cyst (between calipers) with anechoogenic content and a fine septum, immediately caudal to the hyoid bone (arrow). Asterisk: mylohyoid muscle, arrow heads: epiglottis.

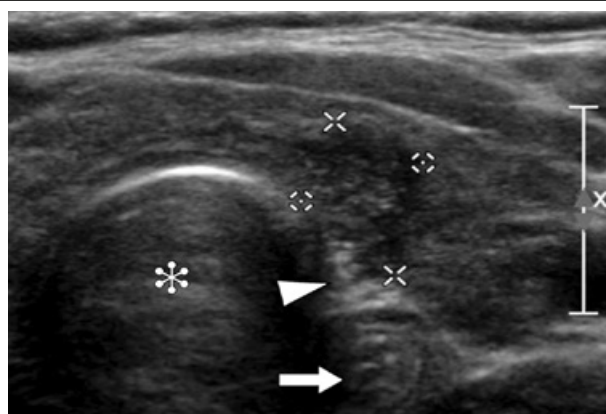


Fig 6. Papillary thyroid carcinoma (between calipers) that presents protrusion towards the esophageal groove (arrowhead) without involving it completely. Asterisk: trachea, arrow: esophagus.

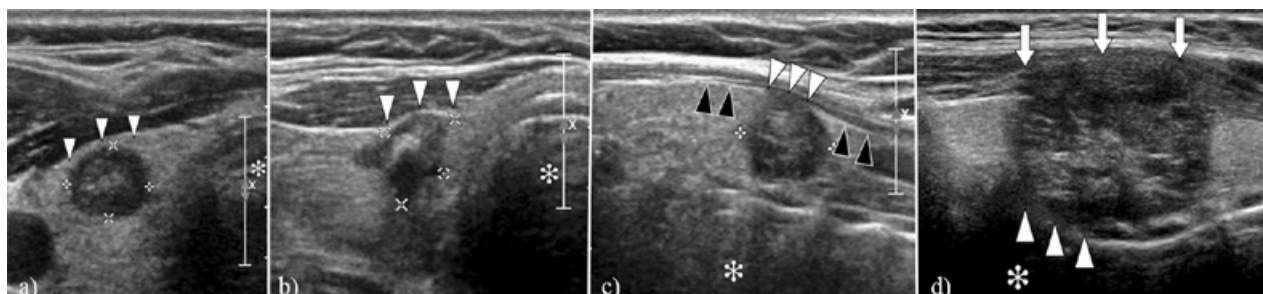


Fig 5. Different cases of papillary thyroid carcinoma (PTC) that present progressive involvement of the capsule up to the marked extrathyroidal extension: a) PTC completely surrounded by healthy parenchyma (arrow heads); b) PTC that comes in contact without involving the capsule (arrow heads), which presents a linear hyperechogenic appearance; c) PTC that involves the capsule (white arrow heads), becoming hypoechogenic unlike the linear hyperechogenic appearance of the normal capsule (black arrow heads). There is no extension towards the infrahyoid muscles; d) PTC with marked extension towards the infrahyoid muscles (arrows), and towards the trachea with loss of definition of its cartilages and membrane (arrow heads). Asterisk: trachea.

Assessment of the lymph nodes

The presence of microcalcifications and cystic changes have a proven specificity of up to 100%, but low sensitivity for lymph node metastasis [10]. The presence of

peripheral vascularization is the criterion of malignancy with a better sensitivity-specificity ratio (fig 8) [5].

The loss of hyperechogenic hilum has shown a specificity of only 29%. However, due to the high sensitivity

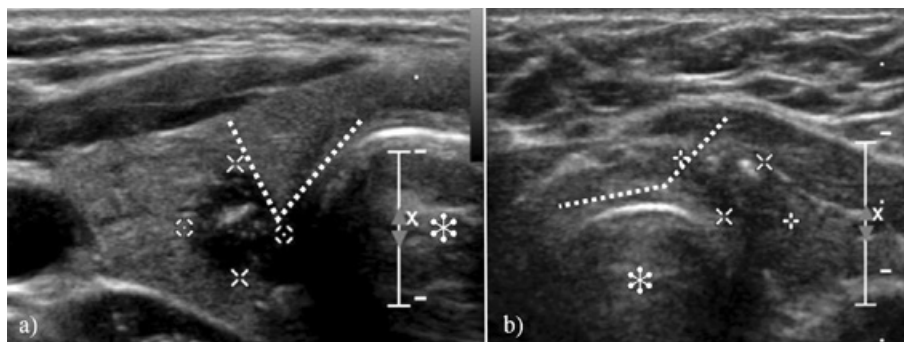


Fig 7. Different cases of papillary thyroid carcinoma (PTC): a) PTC that presents an acute angle in relation to the trachea (asterisk), unlike b), which presents an obtuse angle, with this one being of greatest risk for tracheal invasion.

of this finding (100%), the presence of the fatty hilum makes it possible to exclude the presence of a malignancy with some certainty [10].

Hyperechogenicity of the parenchyma and rounded morphology has shown specificity of only 18% and 54%, respectively, to determine malignancy; therefore, it is recommended that these criteria to be used with other auxiliary criteria such as increased size or those previously mentioned [10,11].

Limitations of US

Preoperative computed tomography (CT) or magnetic resonance imaging (MRI) are recommended as a complement to US for patients with a clinical suspicion of advanced disease [12] (fig 9, fig 10). Patients who present voluminous or widely distributed adenopathies could

present involvement of some lymphatic groups difficult to visualize with routine preoperative US [12].

Staging of DTC

In the 8th edition of the American Joint Committee on Cancer (AJCC) from 2018, significant changes for the staging of patients with DTC were reported (23-35% of down-staging) [13]. These changes are meant to avoid the overtreatment of patients at low risk of malignancy [14,15].

Active surveillance

Active surveillance is considered a safe option for managing patients with low-grade asymptomatic DTC <1 cm and with no high-risk factors such as the presence of metastatic lymph nodes, distant metastasis, a fine-needle biopsy with findings of high-grade malignancy or

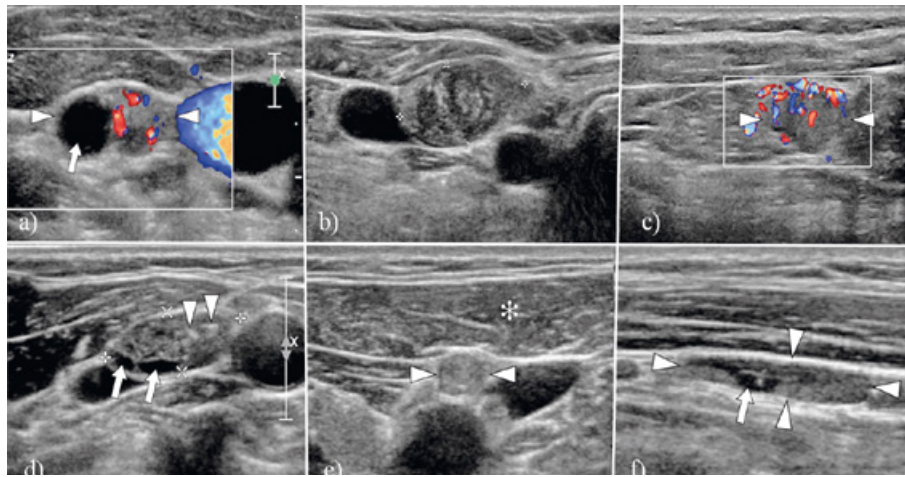


Fig 8. Different cases of lymphatic metastasis of papillary thyroid carcinoma: a) adenopathy (arrowheads), with solid component of heterogeneous echogenicity and peripheral vascularization in color Doppler mode and anechogenic cystic component (arrow); b) adenopathy with loss of echogenic hilum, heterogeneous echostructure and microcalcifications; c) adenopathy with heterogeneous echostucture, loss of echogenic hilum and penetrating peripheral vessels in color Doppler mode; d) adenopathy of heterogeneous echostucture, loss of echogenic hilum, with presence of calcifications (arrow heads) and small peripheral cystic areas (arrows); e) adenopathy (arrow heads) of heterogeneous echostructure, with loss of echogenic hilum, isolated microcalcifications, emphasizing greater overall echogenicity than the adjacent sternocleidomastoid muscle (asterisk); f) adenopathy (arrow heads) with small cystic area, similar in appearance to a thyroid colloid cyst (arrow).

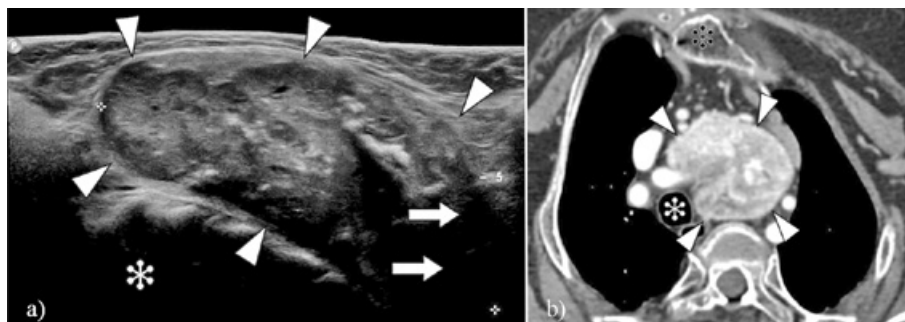


Fig 9. Papillary thyroid carcinoma (arrowheads) that at the time of the study with ultrasound (a) presented an extension towards the mediastinum (arrows), which limited the complete assessment; b) CT of the same patient demonstrates the great intrathoracic involvement not visualized by ultrasound. White asterisk: trachea, black asterisk: sternum.

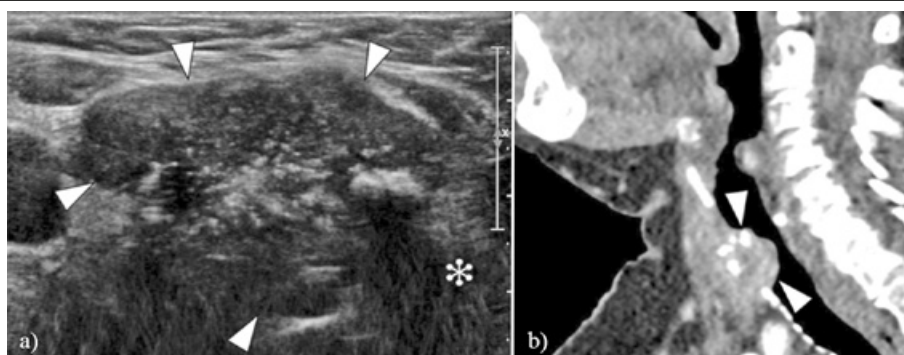


Fig 10. Papillary thyroid carcinoma (arrowheads) that at the time of the study with ultrasound (a) presented an extension towards the trachea (asterisk), difficult to characterize; b) CT of the same patient better demonstrates the tracheal invasion (arrow heads). Asterisk: trachea.

tumors that invade the trachea or the recurrent laryngeal nerve [16].

Conclusions

Nowadays, US is the best tool to conduct an adequate preoperative study of DTC. Whoever does the preoperative study must be familiar with the relevant aspects of the technique, important findings that must be assessed and added to the report, as well as an in-depth understanding of anatomy and ultrasound signs that can differentiate conditions that will mark the prognosis and therapeutic approach. Emphasis must be placed on the evaluation of ETE and lymphatic involvement and complemented with additional studies in cases where US is insufficient.

Conflict of interest: none

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