Thyroid gland ultrasound - How to perform and report? Practical check-list protocol.

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Learning objectives

The purposes of this educational presentation are:


2. To produce anatomical schemes with didactic purpose and show correlations with sonographic imaging.

3. To show high-quality pictures of common pathological findings (thyroid nodules, diffuse thyroid abnormalities, enlarged parathyroid glands) together with practical hints how to recognize them and how to report.

4. To introduce essentials of Thyroid Imaging Reporting and Data System (TIRADS) - an ultrasound reporting system for thyroid nodules stratifying cancer risk for clinical management.

5. Special focus on sonoelastography in evaluation of focal lesions.

Background

Ultrasonography is the single-most valuable imaging modality in the evaluation of the thyroid gland. In many radiology departments it is one of the most frequently performed ultrasound examinations.

Findings and procedure details

Anatomy

Thyroid is an endocrine gland located in anterior inferior part of the neck. It is described as butterfly-shaped and it is built by two cone-like lobes and isthmus between them. Isthmus is located in front of superior part of trachea and connects both lobes. Some patients (in some researches up to 50%) reveal extra lobe that is extended usually from midline of isthmus even to the root of the tongue. That extra lobe is called the pyramid
lobe due to its shape and it is remnant of thyroglossal duct. It is important not to forget about possibility of presence of the pyramid lobe due to the fact, that all pathological changes typical for thyroid can occur also there.

Thyroid is covered by a two-layered fibrous capsule. Inner layer penetrates the gland with nerves and vessels. Parathyroid glands, usually two glands on each side, are placed on the posterior side of thyroid lobes between layers of the sheath. The thyroid is covered anteriorly with infrahyoid muscles and laterally with the sternocleidomastoid muscles. Posteriorly it adjoins to the prevertebral fascia. Lateral lobes reaches oblique line of thyroid cartilage in cranial direction and 5th ring of trachea in caudal direction. Posterior border of the left lobe sticks to the oesophagus (Fig. 1).

**Fig. 1:** Normal thyroid, transverse section. R - right lobe of the thyroid; L - left lobe of the thyroid; I - isthmus; T - trachea; O - oesophagus; IH - infrahyoid muscles; A - right common carotid artery

**References:** Department of Radiology, Wroclaw Medical University, University Hospital - Wroclaw/PL

The thyroid is supplied with arterial blood from the superior thyroid artery (branch of the external carotid artery), the inferior thyroid artery (branch of the thyrocervical trunk) and in some patients (5-10%) by the thyroid ima artery, branching directly from the subclavian artery. The venous blood is drained via superior thyroid veins, draining in the internal jugular vein, and via inferior thyroid veins, draining via the plexus thyroideus impar in the left brachiocephalic vein. The most common lymphatic drainage pattern is to the lateral deep cervical lymph nodes and pre- and paratracheal lymph nodes. Thyroid is nerved by parasympathetic nerves: superior laryngeal nerve and the recurrent laryngeal nerve, branches of the vagus nerve.
Scanning technique

Basic technical requirements of thyroid examination is ultrasound device with linear high frequency probe (at least 7MHz) and Color or Power Doppler visualization.

Patient should be laid symmetrically on the back on a high table with stretched out neck and a pillow under shoulders.

The "first look" should be performed through the transverse placement of the transducer to estimate width, thickness and location of the lobes. Imaging in longitudinal section is valuable to estimate structure of the gland and its vertical size. Structure and vascularity of focal lesions should be estimated in both sections to avoid misinterpretation caused by e.g. vessels. Every examination of the thyroid gland should contain evaluation of cervical lymph nodes.

Structure of the report

Each report should contain information about used device.

- Measurements

Each diameter should be measured for both lobes: maximal width and depth from transverse section image (Fig. 2.) and height from vertical image.
Fig. 2: Measuring of right lobe of thyroid, transverse section.

References: Department of Radiology, Wroclaw Medical University, University Hospital - Wroclaw/PL

Sometimes vertical diameter is too large to visualize it in one picture, therefore horizontal view application can be used or combining two pictures by using dual layer application (Fig. 3).

Fig. 3: Vertical diameter of right lobe of the thyroid. Ultrasound device automatically calculated the volume of the thyroid (marked in the picture) by using also measurements from transverse section. Notice using horizontal view - whole lobe is visible in one picture.

References: Department of Radiology, Wroclaw Medical University, University Hospital - Wroclaw/PL

Nowadays most ultrasound devices have automatic assessment function of thyroid volume based on those measurements. If not it is possible to use internet calculators, or simply count by using correction factor - about 0.53. Volume of the thyroid depends on sex - for men up to 25 ccm, for women to 20 ccm. In authors opinion more sensitive indicator of possible hypertrophia is bulging of anterior border of lobe with indentation and slight compression of infrahyoid muscle group. However its subjectivity and difficulties to prospective control by different physicians using different devices makes volume measurements more useful in everyday practice.

During exam it is also necessary to measure the thickness of the isthmus, which should not exceed 1cm.
-Echogenicity of thyroid parenchyma

Most useful image to estimate echogenicity is vertical section. Echogenicity of regular thyroid is relatively high in comparison to surrounding muscles and it is homogenous. Hipoechogenicity of thyroid parenchyma and its heterogenicity indicates diffuse inflammatory diseases, e.g. Hashimoto disease or subacute thyroiditis.

-Vascularity of thyroid

Vascularity of thyroid can be estimated by using Color (CD) or Power Doppler (PD) application. In physiological state only single vessels are visible. In some pathological states e.g. Graves-Basedow Disease blood flow is visibly increased (Fig. 4).

Fig. 4: Patient with acute state of Hashimoto disease. Increased blood flow is visible in PD option. Image reveals also hipoechegenicity of parenchyma.

References: Department of Radiology, Wroclaw Medical University, University Hospital - Wroclaw/PL

-Focal lesion

Focal lesions are relatively common findings in ultrasound exam of thyroid, especially in areas with iodine deficiency. They can be single or be limited only to one lobe but quite often they appear in both lobes and sometimes in isthmus. If it is possible each focal lesion should be reported. It is important to estimate them in both transversal and longitudinal sections. The report of focal lesion should contain:
Location

Extremely important issue is to describe properly and precisely the location of the lesion. It has enormous matter when it comes to prospective control or biopsy. Generally it is accepted to divide lateral lobes into three parts - upper, middle, and lower and number it from top to bottom. For example lesion in upper part of left lobe can be described as L1, lesion in lower part of right lobe as R3 and lesion between middle part of left lobe and isthmus as L2/I. Some physicians use numbers also to divide isthmus into those three parts, if it is elongated.

Measurements

Focal lesion should be measured in three diameters.

Echogenicity

Echogenicity is very important feature of the focal lesion. Most malignant tumors are hypoechogenic lesions, however hiper or normoechogenicity does not exclude possibility of malignancy.

Echostructure

Homogeneity of focal lesion is another feature that should be reported with particular precision as well as presence of fluid areas and micro and macrocalcifications.

Vascularity

Using CD or PD makes it possible to estimate type of vascularity of lesions:
Type I No blood flow
Type II Perinodular blood flow
Type III Intranodular flow with or without perinodular vessels

There is proof of slight correlation between type IV of vascularity and malignancy of lesion, however at least 50% of type IV vascularity lesion is benign.

Other

Recently developed ultrasonic technique called elastography can make a great impact in differentiation of focal lesions. Its usefulness is based on fact that malignant changes are usually significantly stiffer than benign ones (Fig. 5).
Fig. 5: Elastrography of the thyroid. In the right picture we can see regular B-mode which reveal hypoechogenic focal lesion. Measuring its stiffness, relatively to normal parenchyma, indicates malignant character of the lesion (Ratio A > 4).

References: Department of Radiology, Wroclaw Medical University, University Hospital - Wroclaw/PL
Despite the fact that value of this method for differentiating malignant from benign lesions is being discussed, authors experience confirm its great usefulness to pointing biopsy spot.

Conclusion

Each report should contain conclusion including recommendation about further imaging diagnostic procedures, consultation or biopsy, e.g. by using TIRADS scale. TIRADS scale has been recently developed to unify and simplify such recommendations. It was inspired by BIRADS scale and it is on its way to be "golden standard" in couple of years.

Other

In some situation shape and volume of thyroid can visibly differ from "average". One of the examples is goiter, where thyroid parenchyma is often so rebuilt that it is not possible to distinguish normal parenchyma from pathologically changed. Moreover size of such goiter can be so enlarged that measuring can be possible only by using convex transducer, especially where part of goiter is covered by a sternum.
Opposite situation is where the thyroid size is visibly smaller, e.g. in cases of thyroid or lobar aplasia, after thyroiditis or simply after thyroidectomy.

All the examinations were performed on Toshiba Aplio 500 ultrasound machine using high frequency linear probe (7.2-18 MHz).

Conclusion

1. Form of easy to follow check-list protocol is in our opinion ideal solution that minimizes the risk of missing any important part of examination, makes all the reports standardized and therefore accessible for clinicians to interpret.

Personal information

References