

## ANNEX 2

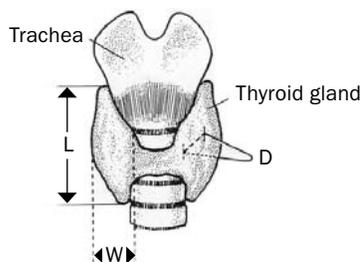
# Method for determining thyroid size by ultrasonography

Thyroid gland size can be measured in the field by ultrasonography. In choosing an echocamera for this purpose, durability, reliability, good screen quality, sharp focus, and an easy-to-use marking system should be emphasized. The machine should be equipped with a high resolution, real-time, 4 to 6 cm linear, 7.5–10 MHz transducer.

### A2.1 Location and anatomy of the thyroid gland (Figure 3)

- Superficial, butterfly-shaped gland in lower, anterior portion of neck.
- Right and left lobes are connected at midline by isthmus.
- Lateral borders: common carotid artery and internal jugular vein.
- Medial border: trachea.
- Anterior borders: sternocleidomastoid, sternothyroid, and sternohyoid muscles.
- The normal thyroid is variable in size. At age 6 to 12 years, its approximate weight is 15–25 g.

**Figure 3** *Anatomic description of the thyroid gland*



Width (W): medial – lateral dimension  
Depth (D): anterior – posterior dimension  
Length (L): cranial – caudal dimension

## A2.2 Sonographic appearance

- The normal thyroid is mid-gray with medium-level echoes and an even, homogeneous texture.
- Lobes appear more echogenic or hyperechoic to adjacent muscles.
- Branches of intrathyroid arteries and veins may appear as 0.5–1.0 mm anechoic tubular, linear structures, but they are rarely delineated.
- The capsule of the thyroid surrounds the gland and appears as a thin line hyperechoic to the gland parenchyma.
- In diffuse goitre, the gland is enlarged and its echogenicity is slightly enhanced.

## A2.3 Scanning protocol

### A2.3.1 Subject position

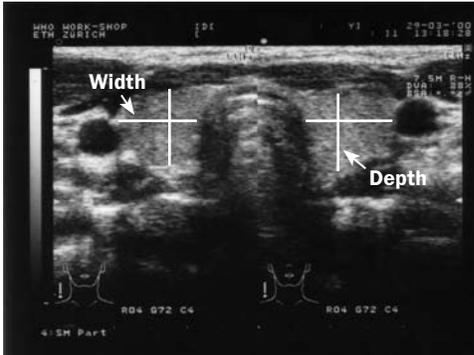
- Children can be measured supine with a pillow or rolled towel under the shoulders to maintain neck extension. Alternatively, they can be seated upright in a hard-backed chair with their back and shoulders straight, neck mildly hyperextended, and head turned slightly away from side of interest.
- The standing position is generally not recommended because of instability.

### A2.3.2 Transducer

- Water-soluble gel is used.
- Transducer held at a 90-degree angle to skin, using only minimal pressure so as not to distort the gland anatomy.

### A2.3.3 Transverse Study (Figure 4)

- Best done on a split screen, visualizing both lobes per screen.
- The trachea with its echogenic cartilage rings and air shadows appears in the midline; the echo-free lumina of the carotid arteries (pulsation) and jugular veins (distension on Valsalva) delineate the lateral aspect.
- Begin with the transducer perpendicular in the transverse plane above the sternal notch; move the transducer superiorly to view the entire gland from inferior to superior aspect; return to image which shows the lobe at its greatest depth and width; and freeze the image.
- Change to other side of the screen, repeat scan on opposite lobe, and freeze.
- Measure the maximal width (mediolateral) and depth (anteroposterior) of the transverse section of each lobe, with the depth measurement at a 90-degree angle to the skin surface and the width measurement at 90 degrees to the depth measurement.

**Figure 4 Transverse scan**

- The measurement should not include the thyroid capsule (hyperechoic to the gland tissue) or the thyroid isthmus.
- Note that the carotid, particularly in a subject with an enlarged thyroid, may indent the posterolateral aspect of the gland.

#### A2.4 Longitudinal Study (Figure 5)

- One thyroid lobe is measured per screen. The strap muscles appear anteriorly as hypoechoic structures relative to the thyroid. Posterior to the medial portion of the thyroid, the trachea with its echogenic cartilage and air shadows is often seen. Posterior to the lateral portion of the thyroid, venous structures and the common carotid appear as echo-free tubular structures.
- Begin with the transducer perpendicular in the sagittal plane above the sternal notch, move the transducer superiorly to view the entire gland from inferior to superior and medial to lateral aspect, return to

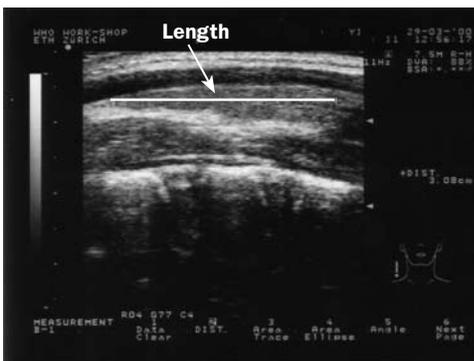
**Figure 5 Longitudinal scan**

image which shows the lobe at its greatest length (craniocaudal), and freeze.

- To obtain the greatest length, because of the inferior convergence of the lobes, the transducer is often oriented with its superior end slightly diverging from the midline. Measure the maximal length of the longitudinal section of the lobe.
- Repeat scan on opposite lobe and again measure the maximal length of the longitudinal section.
- If the length of the gland exceeds the length of the transducer, the longitudinal measurement is done by splitting the lobe length in two scans, measuring to an internal (preferable) or external landmark, and summing the measurements to obtain the length.

### A2.5 Calculation of thyroid volume and body surface area

The volume of the lobe is calculated from the measurements of the depth (d), the width (w), and the length (l) of each lobe by the formula:

$$V \text{ (ml)} = 0.479 \times d \times w \times l \text{ (cm)}$$

The thyroid volume is the sum of the volumes of both lobes. The volume of the isthmus is not included.

Thyroid volume can be easily calculated using a calculator or personal computer during data entry. Portable ultrasound equipment is relatively rugged, but requires electricity. However, it can be operated from a car battery with the aid of a transformer. Trained operators can perform up to 100 or more examinations per day.

The body surface area is calculated using the formula of Dubois and Dubois (39):

$$BSA \text{ (m}^2\text{)} = W^{0.425} \times H^{0.725} \times 71.84 \times 10^{-4}$$

It should be emphasized that by using the ultrasonography criteria, a thyroid gland will be called goitrous when its values will be above the 97th percentile of the volume found in an iodine-replete population used as control. Reference values for the 97th percentile for thyroid volume, as a function of both age and body surface area (BSA), are available (33). In areas with a high prevalence of protein-energy malnutrition, the BSA reference is recommended.