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SHORT COMMUNICATION

MEASUREMENT OF THYROID SIZE BY ULTRASOUND, PALPATION AND SCINTISCAN

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SUMMARY. Thyroid gland size was calculated from grey-scale ultrasound images in twenty patients with goitre. Results were compared with measurements by palpation and in some cases with measurements by scintiscan and at operation. There was a good correlation between ultrasound measurements and both the size of surgical specimens and clinicians' estimations, although clinicians under-estimated the size of large (> 40 ml) goitres compared with ultrasound and surgical specimens. Gland size calculated from scintiscan did not correspond well with measurements by ultrasound or palpation.

A method for accurately measuring thyroid gland size would facilitate precise calculation of therapeutic radioiodine dosage and provide an objective record of gland size in patients with non-toxic goitre. Assessment of thyroid size by palpation (Soley *et al.*, 1949; Williams *et al.*, 1949; Smith & Wilson, 1967) and by thyroid scan (Myhill *et al.*, 1965) is inaccurate and we report the use of ultrasound for this purpose. Results are compared with measurements by palpation, by thyroid scintiscan and at operation.

Patients and methods

Twenty patients were studied and repeated ultrasound measurements were made in nine. Two had Graves' Disease and eighteen had non-toxic goitre (clinically diffuse in three, multinodular in ten, a single palpable nodule in five). Nine were receiving thyroxine suppressant therapy.

Estimations of thyroid size by palpation were made independently by two clinicians. Eight patients underwent partial thyroidectomy and surgical specimens were weighed; Nodules were measured in three dimensions (a, b and c) and the volume calculated from the formula $4/3\ \pi$ a.b.c.

Thyroid size was also measured by grey-scale ultrasound imaging (England *et al.*, 1978). Patients were scanned supine with the neck slightly extended and resting on a foam rubber head rest. A closed waterbag provided a constant water path between the transducer face and skin surface. A thin layer of viscous jelly was used to couple the waterbag to the patients

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neck and to the transducer face. A series of compound sector B-Scans was made, starting at the level of the clavicles and moving up at 1 cm intervals until the region occupied by the thyroid gland was adequately covered. Longitudinal scans were also taken, at mid-line and at 1, 2 and 3 cm on either side of the mid-line. In the case of very large goitres the number of longitudinal scans was increased as appropriate. The diasonograph was interfaced to a Varian 620/L computer, which was used to acquire echo-amplitude information concurrently with routine scanning. Life-size grey-scale images were then formed by the computer in which the areas occupied by thyroid tissue were delineated. Cross-sectional areas were measured by planimetry and the 1 cm spacing allowed volume calculation by summation of these cross-sectional areas. Where the size of nodules was measured the axes of the nodule were measured from the images and volume calculated using the formula $4/3\ \pi$ a.b.c.

In twelve untreated patients gland volume was also calculated from thyroid scintiscans taken 20 min after 1 m curie Technetium^{99} intravenously, using a selo scanner with isocount format. The thyroid outline was drawn at 25% of the peak counts, which corresponded to the edge of phantom thyroids of various sizes filled with radioactivity and similarly scanned (P. W. Horton, personal communication). The area (A) within this contour was measured and the volume (V) calculated using the formula $V = 0.36A^{\frac{3}{2}}$ (Himanka & Larsson, 1955).

Measurements by different methods were compared only when made within two weeks, without change in treatment. Ultrasound measurements were compared with each clinician's estimation on thirty-one occasions, with scan measurements on twelve occasions and with surgical specimens on eight occasions.

Results

Repeated ultrasound measurements. Repeated ultrasound measurements within 2 weeks were made in three patients, respectively with a barely palpable gland, a moderate sized goitre and a large goitre. Mean values (± SEM) were 18 ml ± 3.0 (three measurements), 33 ml ± 1.0 (three measurements) and 227 ml ± 21.0 (two measurements).

Palpation. There was a highly significant linear correlation between the estimations of thyroid size by two clinicians ($r = 0.87$, $P < 0.001$) and there was no systematic bias between them.

Ultrasound measurements and palpation. Although the overall correlation between ultrasound measurements and estimations of gland size by palpation was highly significant, clinicians consistently under-estimated the size of large glands (Fig. 1). The regression line for ultrasound measurements of 40 ml and less did not differ significantly from the 45° line but for glands greater than 40 ml the regression line fell significantly below the 45° line (Fig. 1).

Thyroid gland size calculated from scintiscan. Gland size calculated from thyroid scintiscan did not correlate significantly with measurements by ultrasound ($r = 0.45$) or by palpation ($r = 0.47$ and $r = 0.30$, respectively).

Surgical specimens. Despite the small number there was a significant correlation between the size of surgical specimens and measurements by ultrasound ($r = 0.88$, $P < 0.05$). Clinicians' estimations of whole gland size corresponded closely for glands of 40 ml or less but for larger specimens whole gland size was less in each of four cases.

Discussion

Ultrasound examination of the thyroid gland is of value in distinguishing cystic from solid thyroid nodules (Fujimoto *et al.*, 1967; Thijs, 1971; Rasmussen *et al.*, 1971; Blum *et*

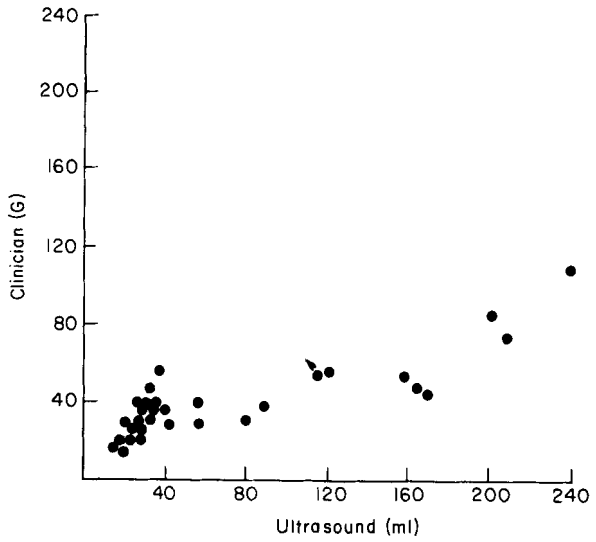

Fig. 1. Comparison of estimations of thyroid size by palpation (one clinician) and by ultrasound ($r = 0.85, P < 0.001$). The regression line for ultrasound measurements of 40 ml or less did not differ significantly from the 45° line (slope 0.985) while for glands greater than 40 ml the regression line fell significantly below the 45° line (slope 0.374, $P < 0.05$).

al., 1972; Miskin *et al.*, 1973; Jellins *et al.*, 1975), in distinguishing haemorrhage from malignant neoplasm in a rapidly enlarging gland (Blum *et al.*, 1972; Thijs & Wiener, 1976) and in identifying suppressed thyroid tissue associated with a hot nodule (Thijs, 1971). This technique provides a useful record of change in size of thyroid nodules, even during thyroid hormone suppressant therapy (Blum *et al.*, 1972; Thijs & Wiener, 1976).

Yamakawa & Naito (1966) described a method for calculating whole gland size from repeated ultrasono-tomograms of the neck. Leclere *et al.* (1974) and Rasmussen & Hjorth (1974) found difficulty in accurately defining the thyroid outline on ultrasound, although the latter reported a good correlation with surgical specimens. By using digitisation techniques (England *et al.*, 1978) we obtained reproducible results. Ultrasound measurements were consistently greater than clinical estimations of large goitres but corresponded well with measurements of surgical specimens. These findings are in keeping with previous observations that clinicians underestimate the size of large glands compared with measurements by scan (Blomfield *et al.*, 1959) and at operation (Williams *et al.*, 1949; Smith & Wilson, 1967).

Calculation of gland size from thyroid scintiscan did not correspond closely with clinical estimations or with ultrasound measurements in this series. Myhill *et al.* (1965) also found that calculation of thyroid size from scintiscan was of limited value, although more precise than palpation.

We conclude that measurements of thyroid gland size by ultrasound are accurate, reproducible and repeatable even in patients receiving thyroid suppressant therapy.

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