Reconfirmation of the accuracy of the taller-than-wide sign in multicenter collaborative research in Japan

Mitsuhiro Fukushima¹, Nobuhiro Fukunari², Tsukasa Murakami³, Yo Kunii⁴, Shinichi Suzuki⁵ and Masafumi Kitaoka⁶

¹ Department of Surgery, Kuma Hospital, Hyogo 650-0011, Japan
² Thyroid Center, Showa University Northern Yokohama Hospital, Kanagawa 224-8503, Japan
³ Department of Endocrinology, Noguchi Thyroid Clinic and Hospital Foundation, Oita 874-0902, Japan
⁴ Department of Internal Medicine, Ito Hospital, Tokyo 150-8308, Japan
⁵ Department of Thyroid and Endocrinology, Fukushima Medical University School of Medicine, Fukushima 960-1295, Japan
⁶ Department of Endocrinology and Metabolism Center, IMS Miyoshi General Hospital, Saitama 354-0041, Japan

Abstract. The taller-than-wide sign indicates that the anteroposterior dimension-to-transverse dimension ratio (AP/T ratio) is higher than 1. The aim of the present study was to reconfirm the accuracy of the taller-than-wide sign for diagnosing malignant thyroid nodules by ultrasonography in multicenter collaborative research, and investigate differences according to tumor sizes, histological types, and the influence of the tilt and orientation of the probe. At 6 registered institutes, 2,032 thyroid nodules were successively operated on and diagnosed pathologically. The accuracy of the taller-than-wide sign for diagnosing malignant tumors by ultrasonography was retrospectively analyzed across all nodules as well as in analyses separately stratified by tumor size and histology. The influence of the tilt and orientation of the probe was also assessed. The taller-than-wide sign showed high specificity for diagnosing malignancy in all nodules tested. It also showed high specificity regardless of the tumor size. When tumors were analyzed by histological types, the AP/T ratio of papillary carcinoma was significantly higher than that of benign nodules, whereas no significant difference was observed between follicular carcinoma and benign nodules. The specificity of longitudinal sections was significantly higher, while the AUC of longitudinal sections was significantly larger than those of transverse sections. The AP/T ratio obtained when the probe was tilted was not significantly different from that when it was straight. The present results support the usefulness of the taller-than-wide sign for diagnosing malignant tumors regardless of size, but not follicular carcinoma. The influence of the tilt and orientation of the probe was negligible.

Key words: Taller-than-wide, Thyroid carcinoma, Thyroid tumor, Ultrasonography, Anteroposterior dimension-to-transverse dimension ratio

MALIGNANCY is suspected in nodules with an anteroposterior dimension-to-transverse dimension ratio (AP/T ratio) higher than 1. This is referred to as the “taller-than-wide” sign (Fig. 1a, b, c, d) [1-7]. This sign has been adopted to diagnose malignant thyroid nodules using ultrasonography by the American Thyroid Association (ATA), European Thyroid Association (ETA), American Association of Clinical Endocrinologists (AACE)/American College of Endocrinology (ACE)/Associazione Medici Endocrinologi (AME), and Korean Society of Thyroid Radiology (KSThR) [8-11], but is not listed in the Japanese guidelines. Although interobserver variations have been reported [12, 13], measurements of anteroposterior and transverse dimensions are relatively objective and do not depend on the experience of sonologists; [7] therefore, data on the AP/T ratio from different institutes may be easily collected and combined. Previous studies reported that the specificity of the AP/T ratio was high, while its sensitivity ranged between 15.0 and 76.0% (Table 1) [1-7].

Although the taller-than-wide sign is useful for diagnosing malignant thyroid nodules, its accuracy has not yet been examined in detail using a sufficient number of cases. Therefore, we herein reconfirmed the accuracy of the taller-than-wide sign in multicenter collaborative research, and investigated differences according to tumor sizes, histological types, and the influence of the tilt and
orientation of the probe.

Patients and Methods

The study protocol was approved by the Institutional Review Board of Showa University Northern Yokohama Hospital. Informed consent was waived because data were collected and analyzed retrospectively after personal information had been erased.

This retrospective study was performed by collecting data obtained by ultrasonography, which was conducted before a cytological diagnosis, from medical charts. Between April 2016 and May 2018, 2,032 thyroid nodules were successively operated on and diagnosed pathologically at 6 registered institutes. While measurements from transverse and longitudinal sections were available for most cases, data from transverse sections were only available for two registered nodules. The

---

Table 1  Previous findings

| First author [Reference No.] | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | Accuracy (%) | Comments |
|------------------------------|----------------|----------------|---------|---------|--------------|----------|
| Kim [1]                      | 32.7           | 92.5           | 66.7    | 74.8    | 73.5         | Non-palpable solid nodules |
| Iannuccilli [2]              | 44.1           | 72.2           | 60.0    | 57.8    | 58.6         | Nodules >1.0 cm |
| Cappelli [3]                 | 76.0           | 60.0           | 8.3     | 98.0    | 60.7         |          |
| Kim [4]                      | 24.1           | 100.0          | 100.0   | 56.2    | 68.6         | Non-palpable solid nodules |
| Moon [5]                     | 15.0           | 91.4           | 77.4    | 67.4    | 69.6         |          |
| Moon [6]                     | 68.0           | 82.1           | 57.8    | 87.7    | 78.3         |          |
| Ren [7]                      | 25.0           | 93.5           | 75.0    | 61.7    | 63.6         | Nodules >1.0 cm |
| The present study            | 36.5           | 88.5           | 80.1    | 52.4    | 59.5         |          |

These findings and the present results confirmed that the specificity of the AP/T ratio is high; however, this is in contrast to the findings reported by Cappelli.

Note: PPV, positive predictive value; NPV, negative predictive value
median age of patients (males/females, 378/1,654) was 53 years (13–92 years). Although all nodules with a pathological diagnosis were examined, recurrent tumors after surgery, nodules treated with percutaneous ethanol injection therapy (PEIT), and tumors after external irradiation were excluded because the original nodule shape may have been modified or deformed. Nodules comprising cysts that occupied 50% or more of the nodule were defined as cystic nodules and were also excluded because cystic formation was suspected to show concentric enlargement by itself. Nodules that developed below the clavicle and those that were not easily measured were excluded. The indication for surgery for malignant tumors, except for follicular carcinomas (FC), was based on the results of fine needle aspiration cytology. On the other hand, the indication for surgery for benign nodules was selected by each surgeon at each institute, and benign nodules included those that were removed together with malignant tumors. Nodules consisted of 896 benign nodules (606 adenomatous nodules/adenomatous goiters (AG), 288 follicular adenomas (FA), and 2 others) and 1,136 malignant tumors (994 papillary carcinomas (PC), 101 FC, 18 medullary carcinomas, 11 lymphomas, 10 poorly differentiated carcinomas, and 2 anaplastic carcinomas).

The accuracy of the taller-than-wide sign, indicating an AP/T ratio higher than 1, for diagnosing malignant tumors by ultrasonography was analyzed in all nodules as well as in three groups divided by tumor size. Since an AP/T ratio of more than 1 indicates the taller-than-wide sign, the sensitivity and specificity of measurements were assessed using a cut-off AP/T ratio of 1. An AUC (Area Under the Curve)-ROC (Receiver Operating Characteristic) curve analysis of all nodules (n = 2,032) was performed. We also investigated whether the pathological diagnosis affected the AP/T ratio.

Ultrasonic examinations were performed on XG, Aplio 400, 500 (TOSHIBA), or iU22 (Philips Healthcare) using an 8–15-MHz linear-array transducer. More than 10 sonographers and some physicians at the 6 registered institutes examined and recorded tumor diameters, according to which the AP/T ratio was calculated. All examiners were certificated as Registered Medical Sonographers or Board Certified Fellows by The Japan Society of Ultrasonics in Medicine (JSUM) or were consulted with for every examination. Measurements were performed under the rule that the transverse dimension in longitudinal and transverse sections was parallel to the skin, while the anteroposterior dimension was at right angles to the transverse dimension, and Board Certified Fellows re-measured these dimensions during reviews where necessary. Data obtained from transverse sections were mainly used in the present study, even though the taller-than-wide sign was only shown in longitudinal sections. All images were reviewed by Board Certified Fellows after the examination at each institute, and they corrected the data obtained before sending for the present study where necessary. Risk stratification systems were used before fine-needle aspiration cytology at each institute; however, these data were not collected in the present study.

We examined the effects of the orientation of the ultrasonic probe in transverse sections (n = 2,032) and longitudinal sections (n = 2,030), and the magnitude of the tilt between when the probe was straight (G1) and tilted at approximately 30° (G2) in 34 cases (10 PC, 24 AG + FA) at Showa University Northern Yokohama Hospital (Fig. 2a, b). The median age of patients (males/females, 8/26) was 63 years (23–79 years). The median diameters of PC and AG + FA when the probe was straight (G1) were 14.0 and 17.6 mm, respectively. Measurements were performed under the same rule and procedure.

Statistical analyses were conducted using the Wilcoxon test, Kruskal-Wallis test, and chi-squared test with the AUC-ROC curve analysis by JMP, SAS Institute Inc., Japan. The Cochran-Armitage trend test
was used to compare sensitivity, specificity, and the positive predictive value (PPV) by JMP, SAS Institute Inc., Japan. The Z test was used to compare AUC by categories of size (≤10 mm, 10–20 mm, and >20 mm), and the De long test was performed to compare AUC by the tumor axis (longitudinal vs. transverse) and probe angle (orthogonal vs. tilted) (JMP, SAS Institute Inc., Japan). A p-value <0.05 was considered to indicate a significant difference.

Results

Among all nodules examined, the AP/T ratio of malignant tumors was significantly higher than that of benign nodules (Fig. 3). Table 2 shows the usefulness of the taller-than-wide sign, indicating an AP/T ratio higher than 1, for diagnosing malignant tumors by ultrasonography according to tumor size. The taller-than-wide sign showed high specificity for diagnosing malignancy in all nodules tested (sensitivity: 36.5%, specificity: 88.5%). In tumors classified by size (≤10 mm, 10–20 mm, and >20 mm), the taller-than-wide sign showed high specificity in all 3 categories (Table 2). The AUC-ROC curve for all nodules had an AUC of 0.70. AUC by size (≤10 mm, 10–20 mm, and >20 mm) were 0.74, 0.59, and 0.58, respectively. Sensitivity and PPV decreased as nodule sizes increased, while specificity significantly increased (p < 0.001). AUC based on the categories of 10–20 mm and >20 mm were significantly smaller than that based on the category of ≤10 mm (p < 0.001). When tumors were examined based on histological types, the AP/T ratio of PC was significantly higher than that of benign nodules (Fig. 4a), whereas no significant differences were observed between FC and benign nodules (Fig. 4b).

Comparisons of the diagnostic values of the taller-than-wide sign by the probe axis are shown in Table 3. The specificity of longitudinal sections was significantly higher than that of transverse sections (p < 0.001), while the AUC of longitudinal sections was significantly larger than that of transverse sections (p < 0.001). Specificity was lower and sensitivity was higher when the AP/T ratio was lower than 1 in either transverse or longitudinal sections than when it was higher than 1 in such sections. In contrast, specificity was higher and sensitivity was lower when the AP/T ratio was lower than 1 in both transverse and longitudinal sections than when it was higher than 1 in such sections. The AUC of either transverse or longitudinal sections and in both sections were larger than that in transverse sections. No significant differences were observed in the AP/T

Fig. 3  The AP/T ratio of malignant tumors is significantly higher than that of benign nodules.

Table 2  Comparison of diagnostic values of the taller-than-wide sign by nodule size

| Categories         | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | Accuracy (%) | Odds ratio | AUC          |
|--------------------|-----------------|-----------------|---------|---------|--------------|------------|--------------|
| All nodules (n = 2,032) | 36.5 (415/1,136) | 88.5 (793/896) | 80.1 (415/518) | 52.4 (793/1,514) | 59.4 (1,208/2,032) | 4.43       | 0.68         |
| ≤10 mm (T1a) (n = 418) | 56.4 (198/351) | 76.1 (51/67) | 92.5 (198/214) | 25.0 (51/204) | 59.6 (249/418) | 4.13       | 0.74         |
| 10–20 mm (T1b) (n = 715) | 35.3 (249/507) | 79.8 (166/208) | 81.0 (179/221) | 33.6 (166/494) | 48.3 (345/715) | 2.16       | 0.59         |
| >20 mm (T2~) (n = 899) | 13.0 (44/278) | 92.8 (576/621) | 44.4 (36/81) | 70.4 (576/818) | 68.1 (612/899) | 1.90       | 0.58         |

Data obtained from transverse sections were used, even though the taller-than-wide sign was only shown in longitudinal sections. Other comparisons, including Table 1 and Table 3, are also based on the results in the transverse section of all nodules, so the results of all nodules are shown in bold here. The taller-than-wide sign showed high specificity for diagnosing malignancy in all nodules tested (sensitivity: 36.5%, specificity: 88.5%). In nodules classified by size (≤10 mm, 10–20 mm, and >20 mm), the taller-than-wide sign showed high specificity in all 3 categories. As nodules increased in size, sensitivity and PPV decreased, while specificity significantly increased (p < 0.001). AUC based on the categories of 10–20 mm and >20 mm were significantly smaller than that based on the category of ≤10 mm (*). Note: PPV, positive predictive value; NPV, negative predictive value; AUC, Area Under the Curve.
ratio when the probe was tilted 30° (G2) and when it was straight (G1) (Fig. 5a, b). Similar results were obtained when malignant and benign cases were analyzed separately (data not shown). The results obtained from comparisons of the diagnostic values of the taller-than-wide sign by the magnitude of the tilt are shown in Table 4. No significant differences were noted in the AUC between G1 and G2 (Table 4).

**Discussion**

Kim et al. previously reported that an AP/T ratio >1 was a strong predictive sign for malignancy and described this finding as "a shape that was taller than wide" [1]. Subsequent studies confirmed this finding, as shown in Table 1. Collectively, these findings and the present results demonstrated that the specificity of the AP/T ratio is high; however, this is in contrast to the findings reported by Cappelli [1-7]. The present results also showed that the AP/T ratio was useful for diagnosing malignant tumors, which was consistent with previous findings. The present study provides evidence to support the usefulness of the taller-than-wide sign for diagnosing malignant tumors regardless of size, as suggested by Ren et al. for micro PC in 2015 [7]. The calculated PPV may have been overestimated because the present study only included nodules removed during surgery, which inevitably increased the prevalence of malignancy in the study population. The malignancy rate was markedly higher than that in real clinical practice, which is a limitation of the

![Fig. 4](a) The AP/T ratio of PC is significantly higher than that of AG.
(b) The AP/T ratio of FC is not significantly different from that of benign nodules.

| Table 3 | Comparison of diagnostic values of the taller-than-wide sign by the probe axis |
|---------|-----------------------------------|
| Axis    | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | Accuracy (%) | Odds ratio | AUC |
|---------|-----------------|-----------------|---------|---------|--------------|------------|-----|
| in transverse sections (n = 2,032) | 36.5 (415/1,136) | 88.5 (793/896) | 80.1 (415/518) | 52.4 (793/1,514) | 59.4 (1,208/2,032) | 4.43 | 0.68 |
| in longitudinal sections (n = 2,030) | 11.4 (129/1,135) | 98.0 (877/895) | 87.8 (129/147) | 46.6 (877/1,883) | 49.6 (1,006/2,030) | 6.25 | 0.73 *p < 0.001 |
| in either of the two sections (n = 2,032) | 39.2 (445/1,136) | 87.7 (786/896) | 80.2 (445/555) | 53.2 (786/1,477) | 60.6 (1,231/2,032) | 4.60 | 0.70 **p < 0.001 |
| in both sections (n = 2,030) | 8.6 (98/1,135) | 98.8 (884/895) | 89.9 (98/109) | 46.0 (884/1,921) | 48.4 (982/2,030) | 7.60 | 0.73 ***p < 0.001 |

The specificity of longitudinal sections was significantly higher than that of transverse sections (p < 0.001). The AUC of longitudinal sections was significantly larger than that of transverse sections (*). However, data obtained from transverse sections are expected to be almost unchanged by the observer, whereas those from longitudinal sections frequently vary because the longitudinal axis may slightly change depending on the observer. The ROC in either of the two sections was drawn based on the larger value from the two sections, while that in both sections was drawn based on the smaller value from the two sections. The AUC in either of the two sections and in both sections were significantly larger than that in transverse sections (**) (***)

Note: PPV, positive predictive value; NPV, negative predictive value.
present study. Cystic nodules were excluded, which is also a limitation of the present study. Grani et al. recently reported that an AP/T ratio ≥1.2 increased specificity for malignancy and reduced the number of suggested biopsies without significantly diminishing overall diagnostic performance [14]. By applying the definition of the AP/T ratio ≥1.2 to our data, the taller-than-wide sign showed higher specificity for diagnosing malignancy in all nodules tested (sensitivity: 8.9%, specificity: 98.0%). This sign is useful in actual clinical practice when specificity is higher than sensitivity. The argument that 1.2 is more accurate than 1 as a threshold may be important in an automatic diagnosis by artificial intelligence (A.I.); however, it may be within the margin of error when it is used as a visual impression in an ultrasonographic diagnosis.

The majority of malignant tumors examined in the present study were PC. When we investigated the AP/T ratio based on the pathological diagnosis of PC, it was higher than that of benign nodules, whereas the AP/T ratio of FC was not significantly different from that of benign nodules (Fig. 4a, b). Further studies are needed to confirm the accuracy of the AP/T ratio for diagnosing malignant tumors other than PC. The present study was only performed on cases diagnosed pathologically after surgery to evaluate FC, which may have been another limitation.

We also examined the effects of the orientation of the ultrasonic probe and magnitude of the tilt on observer variations in multicenter collaborative research. The specificity of longitudinal sections was significantly higher (p < 0.001), while the AUC of longitudinal sections was significantly larger (p < 0.001) than those of transverse sections. However, data obtained from transverse sections are expected to be almost unchanged by the observer, whereas those from longitudinal sections frequently vary because the longitudinal axis may change slightly depending on the observer. Therefore, data obtained from transverse sections may be the most appropriate for multicenter collaborative research, even though specificity was slightly higher in longitudinal sections (Table 3). Moon et al. compared the AUC of the taller-than-wide sign between longitudinal and transverse sections. They reported that the most accurate and sensitive category was the taller-than-wide sign in either transverse or longitudinal sections, and also demonstrated that it was slightly more accurate in transverse sections than in longitudinal sections [6]. The AUC of transverse, longitudinal, and either transverse or longitudinal sections were 0.7096, 0.6925, and 0.7504, respectively, in their study, which were consistent with

Table 4 Comparison of diagnostic values of the taller-than-wide sign by the magnitude of the tilt (n = 34)

| Axis             | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | Accuracy (%) | AUC   |
|------------------|-----------------|-----------------|---------|---------|--------------|-------|
| straight (G1)    | 50 (5/10)       | 70.8 (17/24)    | 41.7 (5/12) | 77.3 (17/22) | 64.7 (22/34) | 0.78   |
| tilted 30° (G2)  | 30 (3/10)       | 70.8 (17/24)    | 30 (3/10) | 70.8 (17/24) | 58.8 (20/34) | 0.66   |

No significant difference was observed in the AUC between G1 and G2 (*).

Note: PPV, positive predictive value; NPV, negative predictive value; AUC, Area Under the Curve.

Fig. 5 (a) The AP/T ratio obtained when the probe was tilted at approximately 30° (G2) was not significantly different from that when it was straight (G1).
(b) The AP/T ratio of G2 correlated with that of G1, and G2 was slightly smaller than G1. Similar results were obtained when malignant and benign cases were analyzed separately (data not shown).
AP/T ratio, anteroposterior dimension-to-transverse dimension ratio; N.S., not significant.
the present results of 0.68, 0.73, and 0.70 (Table 3). The AUC of either transverse or longitudinal sections and of both sections in the present study were also larger than that of transverse sections. However, the AUC of longitudinal sections was larger than that of transverse sections. An ultrasonic probe is generally held upright when applied to the skin, but is often used at an angle to measure nodules that extend toward the mediastinum (Fig. 2a, b). Therefore, the effects of tilting were investigated. The AP/T ratio obtained when the probe was tilted (G2) did not significantly differ from that when it was straight (G1) (Fig. 5a). The AP/T ratio obtained when the probe was tilted (G2) correlated with that when it was straight (G1) (Fig. 5b). No significant difference was observed in the AUC between G1 and G2 (Table 4). Therefore, tilting did not affect the results obtained.

Yoon et al. previously reported that the taller-than-wide sign indicated no or the minimal compressibility of a thyroid mass by the ultrasound probe, which occurs more frequently in malignant masses than in benign masses [15]. The mean AP/T ratio of thyroid masses was significantly lower on ultrasound than on CT, and this difference was significantly greater in benign masses than in malignant masses. These findings indicate that benign nodules are deformed more by probe compression than malignant tumors. Furthermore, benign nodules are proposed to have greater compressibility than malignant thyroid tumors because they are generally softer and infiltrate the surrounding tissue less than malignant masses [15]. Evidence to support this hypothesis was obtained by elastography, which revealed that malignant tumors, particularly PC, were harder masses than benign nodules [16]. Although thyroid nodules are more likely to develop along the long axis of the thyroid, further studies are needed to provide more evidence for this hypothesis. If the taller-than-wide sign is based on deformation by probe compression, further studies are also required to examine differences in nodule depth, particularly for small nodules, because deep small nodules may be deformed less by probe compression.

**Conclusion**

The present results support the usefulness of the taller-than-wide sign for diagnosing malignant tumors regardless of size, but not FC. The influence of the tilt and orientation of the probe was negligible.

**Acknowledgments**

These present results were presented at The World Congress on Thyroid Cancer 3.5 (WCTC 3.5) on June 20–22, Rome, Italy, and awarded 2nd place for ePoster Presentations.

The authors thank all the members of the research group, particularly Ms. Maki Oshita from Kuma Hospital, Dr. Masahide Nakano from Showa University Northern Yokohama Hospital, Dr. Naoyuki Higaki from the Noguchi Thyroid Clinic and Hospital Foundation, Mr. Takashi Amano from Ito Hospital, and Dr. Manabu Iwadate from Fukushima Medical University School of Medicine. The authors are deeply grateful to Prof. Eisuke Inoue from Showa University Research Administration Center, Showa University, for his devoted contributions to statistical analyses.

**Disclosure**

None of the authors have any potential conflicts of interest associated with this research. This research was conducted as a part of research group activities by the Japanese Association of Breast and Thyroid Sonology (JABTS).

**References**

1. Kim EK, Park CS, Chung WY, Oh KK, Kim DI, et al. (2002) New sonographic criteria for recommending fine-needle aspiration biopsy of nonpalpable solid nodules of the thyroid. *AJR Am J Roentgenol* 178: 687–691.
2. Iannuccilli JD, Cronan JJ, Monchik JM (2004) Risk for malignancy of thyroid nodules as assessed by sonographic criteria: the need for biopsy. *J Ultrasound Med* 23: 1455–1464.
3. Cappelli C, Castellano M, Pirola I, Gandossi E, De Martino E, et al. (2006) Thyroid nodule shape suggests malignancy. *Eur J Endocrinol* 155: 27–31.
4. Kim JY, Lee CH, Kim SY, Jeon WK, Kang JH, et al. (2008) Radiologic and pathologic findings of nonpalpable thyroid carcinomas detected by ultrasonography in a medical screening center. *J Ultrasound Med* 27: 215–223.
5. Moon WJ, Jung SL, Lee JH, Na DG, Baek JH, et al. (2008) Benign and malignant thyroid nodules: US differentiation—multicenter retrospective study. *Radiology* 247: 762–770.
6. Moon HJ, Kwak JY, Kim EK, Kim MJ (2011) A taller-than-wide shape in thyroid nodules in transverse and longitudinal ultrasonographic planes and the prediction of malignancy. *Thyroid* 21: 1249–1253.
7. Ren J, Liu B, Zhang LL, Li HY, Zhang F, et al. (2015) A taller-than-wide shape is a good predictor of papillary thyroid carcinoma in small solid nodules. *J Ultrasound Med* 24: 1455–1464.
8. Gharib H, Papini E, Garber JR, Duick DS, Harrell RM, et al. (2016) American Association of Clinical Endocrinologists, American college of endocrinology, and Associazione Medici Endocrinologi medical guidelines for clinical practice for the diagnosis and management of thyroid nodules—2016 update. *Endocr Pract* 22: 622–639.

9. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, et al. (2016) 2015 American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: the American Thyroid Association Guidelines Task Force on Thyroid Nodules and Differentiated Thyroid Cancer. *Thyroid* 26: 1–133.

10. Russ G, Bonnema SJ, Erdogan MF, Durante C, Ngú R, et al. (2017) European Thyroid Association guidelines for ultrasound malignancy risk stratification of thyroid nodules in adults: the EU-TIRADS. *Eur Thyroid J* 6: 225–237.

11. Shin JH, Baek JH, Chung J, Ha EJ, Kim JH, et al. (2016) Ultrasonography diagnosis and imaging-based management of thyroid nodules: revised korean society of thyroid radiology consensus statement and recommendations. *Korean J Radiol* 17: 370–395.

12. Brauer VF, Eder P, Miehle K, Wiesner TD, Hasenclever H, et al. (2005) Interobserver variation for ultrasound determination of thyroid nodule volumes. *Thyroid* 15: 1169–1175.

13. Persichetti A, Di Stasio E, Coccaro C, Graziano F, Bianchini A, et al. (2020) Inter- and intraobserver agreement in the assessment of thyroid nodule ultrasound features and classification systems: a blinded multicenter study. *Thyroid* 30: 237–242.

14. Grani G, Lamartina L, Ramundo V, Falcone R, Lomonaco C, et al. (2020) Taller-than-wide shape: a new definition improves the specificity of TIRADS systems. *Eur Thyroid J* 9: 85–91.

15. Yoon SJ, Yoon DY, Chang SK, Seo YL, Yun EJ, et al. (2010) “Taller-than-wide sign” of thyroid malignancy: comparison between ultrasound and CT. *AJR Am J Roentgenol* 194: W420–W424.

16. Chong Y, Shin JH, Ko ES, Han BK (2013) Ultrasonographic elastography of thyroid nodules: is adding strain ratio to colour mapping better? *Clin Radiol* 68: 1241–1246.