Short-term Follow-up US Leads to Higher False-positive Results Without Detection of Structural Recurrences in PTMC

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Abstract: To investigate the value of the annual follow-up neck ultrasonography (US) for postoperative surveillance in patients with papillary thyroid microcarcinoma (PTMC).

This retrospective study has been approved by our institutional review board (IRB) with waiver for informed consent. A total of 375 patients diagnosed as PTMCs, who underwent total thyroidectomy with radiiodine remnant ablation were included, to identify the recurrence rate and the false-positive rate of annual ultrasound. The number, interval, and the results of follow-up US or fine needle aspiration were obtained from electronic medical records.

Four (1.1%, 4/375) recurrences were found 3 years after the initial treatment, and only 1 patient (0.3%, 1/375) had a metastatic lymph node larger than 8 mm in the shortest diameter on US found 7.6 years after initial treatment with biochemical abnormalities. Cumulative risk of having at least 1 false-positive exam was 8.3% by the 8th US, and 8.1% by the 8–9 year follow-up. Cox multivariate regression showed shorter interval of follow-up US and presence of lymph node metastasis at initial surgery are independent predictors affecting the cumulative false-positive results (hazard ratio [HR], 0.60; 95% confidence interval [CI]: 0.49–0.73; P < 0.001 and HR, 2.19; 95% CI: 1.01–4.75; P = 0.048, respectively).

Short-term follow-up US can result in higher cumulative false-positive results without detection of meaningful recurrences in patients with PTMCs who do not have biochemical abnormalities.

INTRODUCTION

Ever since Pacini et al.2 suggested that the recombinant human thyroid-stimulating hormone (rhTSH)-stimulated thyroglobulin (Tg) measurement and neck ultrasonography (US) is a superior combination to rhTSH-stimulated Tg measurement and 131I whole body scan in the postoperative surveillance of patients treated with differentiated thyroid cancers (DTCs), US has been widely accepted as the standard follow-up imaging modality for patients with DTCs.2 The combination of stimulated Tg and neck US showed sensitivity of up to 100% for diagnosing recurrences in patients with DTCs.3 US is a highly sensitive diagnostic tool that detects locoregional recurrences in the neck, which is the most common site of recurrence for thyroid cancers.1,4,5 detecting recurrences even when abnormality of Tg levels have not been identified.5–7 However, the clinical value of US surveillance is uncertain for patients with papillary thyroid microcarcinomas (PTMCs), because most PTMCs have an indolent clinical course, and the tumor recurrences come in small volumes that may not affect overall survival of the patient, in which treatment may cause more morbidity than its natural disease progression.8–10

The primary goal of postoperative surveillance is to detect clinically significant recurrences, not to reveal all indolent lesions. The 2015 American Thyroid Association (ATA) guidelines do not recommend fine-needle aspiration (FNA) for very small-sized lymph nodes detected on postoperative surveillance US, even when abnormal US features are observed.2 Although annual US is generally recommended for 3 to 5 years as postoperative surveillance for patients with DTCs,11 we came to wonder how annual US performed for postoperative surveillance may have impact on PTMC patients after surgery. Therefore, we investigated the value of annual follow-up neck US for postoperative surveillance in patients with PTMCs, evaluating the frequency of locoregional recurrences detected on US, and the false-positive rates.

METHODS

Study Cohort

Our institutional review board (IRB) approved of this retrospective study, and the requirement to obtain informed consent was waived. From January 2003 to December 2006, 1486 patients were confirmed to have PTMCs. Total thyroidectomy with radiiodine remnant ablation treatment was performed in 421 patients. Prophylactic central lymph node dissections were routinely performed at our institution. Of the 421 patients, 46 patients were excluded from the study; 9 for not receiving a follow-up for at least 36 months, 2 due to coexisting ovarian cancer and breast cancer, respectively, and 35 with interference of the anti-Tg antibody. Finally, 375 patients (333 women and 41 men) were included (Figure 1). The mean
The age at surgery was 48.5 years (standard deviation [SD], 10 years; median age, 48 years; range, 20–78 years). The mean size of the 375 PTMCs was 6.3 mm (SD, 2.1 mm; median size, 6 mm; range, 2–10 mm).

**Follow-Up Protocol**

All patients underwent thyroid-stimulating hormone (TSH)-suppressive therapy with levothyroxine after surgery and were followed every 6 months for the first 3 years after initial treatment and then yearly afterward. For these patients, we recommended clinical examinations for every 6 months, neck US, chest X-ray, and measurements of serum TSH, free T4, Tg, and anti-Tg antibody for every 12 months. Whole body scan, chest computed tomography (CT), magnetic resonance imaging (MRI), or fluorodeoxyglucose positron emission tomography (PET) was performed only in selective cases (eg, detectable serum Tg or persistent anti-Tg antibody without evident recurrence on US or whole body scan).

Before 2011, monoclonal antibody immunoradiometric assay (IRMA; CIS Bio International, Gif-sur-Yvette, France) was used for serum Tg level assays. Radioimmunoassay was used for measuring serum anti-Tg antibodies (Brahms, Hennigsdorf/ Berlin, Germany, functional sensitivity of 10 IU/mL; positive defined as value exceeding 60 IU/mL), and serum TSH levels (Trinity Biotech, Co. Wicklow, Ireland, reference range of 0.4–3.1 IU/mL, functional sensitivity of 0.0038 mIU/L). From 2011 to the present, electrochemiluminescence immunoassay with an automated immunoassay analyzer (Architect i2000, Abbott Laboratories, Abbott Park, IL, reference range: 0.35–4.94 μIU/mL, functional sensitivity of 0.01 μIU/mL) was used.

Neck US was performed using a 5- to 15-MHz linear array transducer (HDi 5000 or 3000, Philips-Advanced Technology Laboratories, Bothell, WA; iU22, Philips Medical Systems; Logic 9, GE Medical Systems, Milwaukee, WI; Acuson Sequoia 512, Siemens Medical Solutions USA, Inc, Mountain View, CA; EUB-7500, Hitachi Medical, Tokyo, Japan) by 77 radiologists, including 3 faculties who specialized in thyroid imaging, 15 faculties of other specialties, 4 fellows, and 55 residents of the radiologic department. When a lymph node showed loss of fatty hilum, diffuse or focal hyperechogenicity, cystic change, microcalcifications, round shape, or chaotic or peripheral vascularity on US, we regarded it as an abnormal lymph node. Although the follow-up protocol is specifically defined at our institution, a detailed follow-up interval that differs from the institutional guidelines has been chosen at the discretion of the physician or the preference of each individual patient.

**Recurrence**

No clinical evidence of disease was defined as suppressed Tg < 1 ng/mL, stimulated Tg < 2 ng/mL, no detectable anti-Tg antibody, or no evidence of disease on US, CT, MRI, PET/CT, or whole body scan at final follow-up. Persistence was defined as suppressed Tg ≥ 1 ng/mL or stimulated Tg ≥ 2 ng/mL, or any evidence of disease on US, CT, MRI, PET/CT, or whole body scan after initial surgery and radioiodine remnant ablation therapy. Recurrence was defined as “malignancy” on cytology results, elevated serum Tg or uptake on whole body scan in

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**FIGURE 1.** Flow chart of the study group. No structural recurrence, but increased serum thyroglobulin level on final follow-up in 2 patients, and follow-up loss in 2 patients after diagnosis of biochemical recurrence. The patient had a normal serum thyroglobulin level on final follow-up.
patients with no clinical evidence of disease. US-guided FNA (US-FNA) was usually performed for a suspected recurrent mass on US. Cytopathologic results were obtained by US-FNA and surgical excision.

Data and Statistical Analysis

Regarding follow-up US after complete treatment, we comprehensively reviewed the number, interval, and the result of follow-up US, using electronic medical records. If US-FNA was performed to diagnose focal lesions of the neck, these results were also recorded. Relevant data of the included patients were obtained for recurrences or patient mortality from our institution database.

Positive US results were considered true-positive if any atypical or malignant cells were seen on either cytology or pathology. Positive US results were considered false-negative if no atypical or malignant cells were seen on cytology or if the lesion was not visible on the final follow-up US which was performed at least 1 year after the prior follow-up showing positive results. Regarding cases with structural persistence or recurrence as true-positives, we estimated the cumulative risk of false-positive results on follow-up US based on both time-to-event and tests-to-event using the Kaplan–Meier approach.15 Patients who had false-positive or true-negative results were no longer included in the Kaplan–Meier analysis despite the ongoing examinations performed afterwards.

Cox proportional hazards models were used to evaluate factors affecting the cumulative risk of false-positive results on follow-up US by univariate analysis. Multivariate analysis was performed after adjustment for baseline characteristics and known prognostic factors. Firth correction was applied because large point estimates were for the covariate “Dose of RAI” (radioactive iodine). Two-sided P value < 0.05 was considered to indicate statistical significance. Statistical analyses were performed using a computerized statistics program (SAS version 9.2 for Windows; SAS Institute, Cary, NC) and R package, version 3.1.1 (http://www.R-project.org).

RESULTS

Clinical characteristics are presented in Table 1. None of the patients in the study population died during the study period. Mean follow-up duration from initial treatment to the last clinical follow-up was 98.8 months (SD, 19.6 months; median, 98.5 months; range, 36.8–141.9 months). During follow-up, 1.1% (4/375) of the patients had structural recurrences, 0.3% (1/375) had structural persistence, and 1.1% (4/375) had biochemical recurrences (Table 2). All recurrences were detected 3 years after the initial treatment. Of the 4 patients with structural recurrences, 2 had elevated serum Tg levels that was normalized after surgery, and 2 had normal serum Tg levels among which 1 had surgery and was disease-free at final follow-up, and the other patient was followed without any changes observed during follow-up. Among the 4 patients with biochemical recurrence, 2 had stable serum Tg levels during follow-up, and the remaining 2 were lost for follow-up. One patient with structural persistence underwent surgery and was disease-free at final follow-up. There were 33 patients (8.8%, 33/375) who had one or more abnormal focal lesion(s) detected on postoperative surveillance US (Appendix, http://links.lww.com/MD/A599). Most of them (72.7%, 24/33) showed loss of fatty hilum or other nonspecific US features. US-FNAs were performed on 28 focal lesions of 25 patients, and 5 patients (15.2%, 5/33) were diagnosed as metastasis. Among the focal lesions, only 1 measured larger than 8 mm at the shortest diameter.

During the study period, 2346 neck US were performed for postoperative surveillance (Table 3). For the 375 patients, the median number of neck US examinations obtained was 6 (range, 1–14). Among the 375 patients who were examined by neck US, 8.3% (28/375) had at least 1 false-positive US (Table 3). The cumulative risks of having at least 1 false-positive exams were 8.3% by the 8th US and 8.1% by the 8 to 9 year follow-up. After that, the cumulative risk of having at least 1 false-positive exam did not increase.

We evaluated the factors affecting the cumulative risk of false-positive results on follow-up US (Table 4). On univariate analysis, the shorter interval of follow-up US (hazard ratio [HR], 0.60; 95% confidence interval [CI]: 0.50–0.73; P < 0.001) and LNM (HR, 2.4; 95% CI: 1.15–5.06; P = 0.02) were statistically significant factors affecting the cumulative false-positive results on follow-up US. Cox multivariate regression analysis showed that the shorter interval of

| TABLE 1. Characteristics of the Study Cohort |
|-------------------------------------------|
| Characteristic                             | Value |
| Age (years, mean ± SD)                    | 48.5 ± 10 |
| Gender                                    |       |
| Male                                      | 42 (11.2%) |
| Female                                    | 333 (88.8%) |
| Primary tumor                             |       |
| Pathologic size (mm, mean ± SD)           | 6.3 ± 2.1 |
| Multifocality in 1 lobe                   | 36 (9.6%) |
| Bilaterality                              | 96 (25.6%) |
| Extrathyroidal extension                  | 180 (48%) |
| Lymph node metastasis                     |       |
| Central LNM                               | 107 (28.5%) |
| Lateral LNM                               | 22 (5.9%) |
| Distant metastasis                        | 1 (0.3%) |
| AJCC/UICC staging                         |       |
| I                                         | 225 (60%) |
| III                                       | 137 (36.5%) |
| Iva                                       | 13 (3.5%) |
| RAI ablation                              |       |
| 30 mCi                                    | 365 (97.3%) |
| 60 mCi                                    | 8 (2.1%) |
| 90 mCi                                    | 1 (0.3%) |
| 150 mCi                                   | 1 (0.3%) |
| ATA risk stratification                   |       |
| Low-risk                                  | 141 (37.6%) |
| Intermediate-risk                         | 232 (61.9%) |
| High-risk                                 | 2 (0.5%) |
| Status at final follow-up                 |       |
| No evidence of disease                    | 366 (97.6%) |
| Structural persistence                     | 1 (0.3%) |
| Biochemical persistence and structural recurrence | 1 (0.3%) |
| Biochemical recurrence                    | 4 (1%)   |
| Biochemical and structural recurrence     | 1 (0.3%) |
| Structural recurrence                     | 2 (0.5%) |

AJCC/UICC TNM staging = the American Joint Committee on Cancer (AJCC)/Union Internationale Contre le Cancer (UICC) staging (7th ed., 2010). ATA = American Thyroid Association, LNM = lymph node metastasis, RAI = radioactive iodine, SD = standard deviation.
| Age at Diagnosis | Initial Cancer Size, mm | AJCC/UICC Staging | ATA Risk | Time to Recurrence or Persistence, year | Recurrence or Persistence | Location | Size, mm | Treatment | Final Follow-Up | Time of Final Follow-Up, year |
|------------------|--------------------------|-------------------|----------|-----------------------------------------|---------------------------|----------|----------|-----------|----------------|-----------------------------|
| 1 \*              | ≥45                      | 4                 | III      | Intermediate                             | 4                         | Biochemical persistence and structural recurrence | Level 4 | 9 × 5     | Surgery              | Second persistent biochemical disease | 7.3                         |
| 2 \*              | ≥45                      | 9                 | III      | Intermediate                             | 7.6<sup>z</sup>           | Biochemical and structural recurrence             | Level 4 | 16 × 9    | Surgery              | Disease free               | 8.5                         |
| 3                | <45                      | 5                 | I        | Intermediate                             | 4.2                       | Structural recurrence                             | Op bed  | 4 × 2     | None                  | Persistent structural disease | 8.1                         |
| 4                | ≥45                      | 3                 | I        | Low                                     | 3.2                       | Structural recurrence                             | Level 4 | 6 × 3     | Surgery              | Disease free               | 7.5                         |
| 5                | <45                      | 5                 | I        | Intermediate                             | 4.3                       | Biochemical recurrence                             |                    |            |                       | Persistent biochemical disease<sup>†</sup> | 7.3                         |
| 6                | ≥45                      | 4                 | III      | Intermediate                             | 3.9                       | Biochemical recurrence                             |                    |            |                       | Persistent biochemical disease<sup>†</sup> | 7.9                         |
| 7                | ≥45                      | 2                 | I        | Low                                     | 7.8                       | Biochemical recurrence                             |                    |            |                       | Not available<sup>§</sup>      | 7.8                         |
| 8                | ≥45                      | 3                 | III      | Intermediate                             | 7.1                       | Biochemical recurrence                             |                    |            |                       | Not available<sup>§</sup>      | 7.1                         |
| 9                | ≥45                      | 9                 | III      | High                                    | 7 × 7                     | Structural persistence                             | Level 4           |            | Surgery              | Disease free               | 6.8                         |

<sup>†</sup> AJCC/UICC TNM staging = the American Joint Committee on Cancer (AJCC)/Union Internationale Contre le Cancer (UICC) staging (7th ed., 2010), ATA = American Thyroid Association.

<sup>‡</sup> The patients had two suspicious lymph nodes.
<sup>§</sup> All patients had persistently high serum thyroglobulin levels without any increases.
<sup>z</sup> Time to structural recurrence.
<sup>†</sup> No further follow-up data was available after a biochemical recurrence was discovered.
follow-up US and lymph node metastasis are independent predictors affecting the cumulative false-positive results on follow-up US (HR, 0.60; 95% CI: 0.49–0.73; \( P < 0.001 \) and HR, 2.19; 95% CI: 1.01–4.75; \( P = 0.048 \), respectively).

**DISCUSSION**

In this study of patients with PTMCs who underwent total thyroidectomy and radioiodine remnant ablation treatment, locoregional structural recurrence was detected in 1.1% (4/375) of patients at a median follow-up of 98.5 months. Considering the clinical insignificance of small lymph nodes, even with cancer foci, the 2015 ATA guidelines suggest performing US-FNA for suspicious lymph nodes of 5 to 8 mm in the smallest diameter.\(^2\) When considering the size cut-off for diagnostic FNA in lymph nodes, only 1 (0.3%) patient had a metastatic lymph node measuring larger than 8 mm in the shortest diameter on US in this study, who had biochemical recurrence. There were no significant structural recurrences detected among patients without biochemical recurrences.

The goal of postoperative surveillance is to properly detect recurrences which can affect morbidity and mortality from the disease, while minimizing unnecessary invasive biopsies and patient anxiety. Although several guidelines recommend periodic US with serum Tg assessments as postoperative surveillance for patients with DTC, these guidelines do not provide an optimal time length of follow-up intervals for postoperative surveillance US,\(^2,16\) and annual US has been performed empirically for postoperative surveillance.\(^3,5,17\) Recently, false-positive abnormalities have been reported to result from frequent neck US of patients with intermediate risk for PTC.\(^18\) In this study, shorter follow-up US intervals and lymph node metastasis at initial surgery resulted in a higher cumulative false-positive results on follow-up US. Also, all 4 structural recurrences were found 3 years after initial treatment, and 1 metastatic lymph node measuring larger than 8 mm in the shortest diameter was found on US performed 7.6 years after the initial treatment. From our results, we can conclude that the frequent use of highly sensitive US may lead to overuse of invasive procedures such as US-FNA, and cause subsequent psychological distress or economic burden on patients, despite of the lack in established benefits. On the other hand, negative results on follow-up US can lessen patient anxiety that should not be neglected, but as there are no consensus on which interval or duration that postoperative surveillance US should be performed, we expect our results to be a start of future prospective

**TABLE 3.** Cumulative Probability of a First False-Positive Result by Number of Neck USs Performed and by Follow-Up Year in 375 Patients

| Number of Neck USs | Number of False-Positive Results | Number of True-Positive Results | Cumulative False-Positive Results (SE), % |
|-------------------|----------------------------------|---------------------------------|------------------------------------------|
| 1                 | 375 (100)                        | 5                               | 1.33 (0.59)                              |
| 2                 | 368 (98.1)                       | 5                               | 2.67 (0.83)                              |
| 3                 | 360 (96)                         | 10                              | 5.38 (1.17)                              |
| 4                 | 336 (90)                         | 3                               | 6.22 (1.26)                              |
| 5                 | 302 (80.5)                       | 4                               | 7.46 (1.39)                              |
| 6                 | 243 (64.8)                       | 0                               | 7.46 (1.39)                              |
| 7                 | 161 (42.9)                       | 0                               | 7.46 (1.39)                              |
| 8                 | 107 (28.5)                       | 1                               | 8.33 (1.62)                              |
| 9                 | 60 (16)                          | 0                               | 8.33 (1.62)                              |
| 10                | 21 (5.6)                         | 0                               | 8.33 (1.62)                              |
| 11                | 7 (1.9)                          | 0                               | 8.33 (1.62)                              |
| 12                | 3 (0.8)                          | 0                               | 8.33 (1.62)                              |
| 13                | 2 (0.5)                          | 0                               | 8.33 (1.62)                              |
| 14                | 1 (0.3)                          | 0                               | 8.33 (1.62)                              |

| Duration, year | Number of False-Positive Results | Number of True-Positive Results | Cumulative False-Positive Results (SE), % |
|----------------|----------------------------------|---------------------------------|------------------------------------------|
| 0–1            | 295 (78.67)                      | 5                               | 1.34 (0.59)                              |
| 1–2            | 316 (84.27)                      | 1                               | 1.61 (0.65)                              |
| 2–3            | 306 (81.6)                       | 9                               | 4.03 (1.02)                              |
| 3–4            | 299 (79.74)                      | 7                               | 5.94 (1.23)                              |
| 4–5            | 283 (75.47)                      | 4                               | 7.08 (1.34)                              |
| 5–6            | 234 (62.4)                       | 1                               | 7.37 (1.37)                              |
| 6–7            | 218 (58.14)                      | 0                               | 7.37 (1.37)                              |
| 7–8            | 190 (50.67)                      | 0                               | 7.37 (1.37)                              |
| 8–9            | 112 (29.87)                      | 1                               | 8.13 (1.55)                              |
| 9–10           | 68 (18.14)                       | 0                               | 8.13 (1.55)                              |
| 10–11          | 22 (5.87)                        | 0                               | 8.13 (1.55)                              |
| 11–12          | 3 (0.8)                          | 0                               | 8.13 (1.55)                              |

SE = standard error.
It is unclear how many neck recurrences would be clinically significant. A large number of false-positive findings on US signify lymph nodes, with 80.5% (120/149) having benign results on cytology. Durante et al. demonstrated that there were regional recurrences in patients who underwent thyroid lobectomy after applying specific US features in diagnosing locoregional cancer. The loss of fatty hilum is a highly sensitive feature but with low specificity. False-positive results in this study were not strictly controlled, which may have affected the cumulative recurrence rates in patients with thyroid cancers.

There are some limitations to our study. First, this study is retrospective and the exclusion of some cases was inevitable. Also, the interval or duration of follow-up US was not strictly controlled, which may have affected the cumulative false-positive rates of this study. Second, we included patients with PTMCs who underwent total thyroidectomy, bilateral prophylactic central neck dissections, and radioactive iodine remnant ablation treatment. Future studies investigating the role of follow-up US on patients who have been treated less aggressively are anticipated to validate our results. Third, surveillance US was performed by 77 radiologists with variable experiences. Although this reflects data obtained from everyday practice, the quality of US may have been affected. Last, the radiologists were not blinded to the pathology results of the patient, such as tumor stage or LN status, which was not considered in analysis. In spite of these limitations, results of this study suggest that short-term follow-up US can result in higher cumulative false-positive results without detection of meaningful recurrences in patients with PTMCs who do not have biochemical abnormalities.

### Table 4. Factors Affecting the Cumulative Risk of False-Positive Results in Follow-up US by Cox Regression Analysis Using the Firth Correction Method

| Characteristic                  | Univariable HR (95% CI) | P Value | Multivariable HR (95% CI) | P Value |
|--------------------------------|-------------------------|---------|---------------------------|---------|
| US follow-up interval          | 0.60 (0.50–0.73)        | <0.001  | 0.60 (0.49–0.73)          | <0.001  |
| Age ≥45                        | 1.17 (0.53–2.59)        | 0.692   | 1.20 (0.54–2.66)          | 0.659   |
| Gender                         |                         |         |                           |         |
| Male                           | 2.29 (0.93–5.64)        | 0.073   | 1.64 (0.66–4.08)          | 0.293   |
| Female                         | 1 [Reference]           |         | 1 [Reference]             |         |
| Pathologic size, mm            |                         |         |                           |         |
| ≥5                             | 0.98 (0.40–2.41)        | 0.96    | 0.77 (0.30–1.94)          | 0.578   |
| <5                             | 1 [Reference]           |         | 1 [Reference]             |         |
| Extrathyroidal extension       |                         |         |                           |         |
| Positive                       | 0.81 (0.38–1.71)        | 0.577   | 0.98 (0.46–2.09)          | 0.948   |
| Negative                       | 1 [Reference]           |         | 1 [Reference]             |         |
| LNM                            |                         |         |                           |         |
| Positive                       | 2.41 (1.15–5.06)        | 0.02    | 2.19 (1.01–4.75)          | 0.048   |
| Negative                       | 1 [Reference]           |         | 1 [Reference]             |         |
| Dose of RAI                    | 0.64 (0.04–10.99)       | 0.756   | 0.55 (0.03–10.20)         | 0.688   |

CI = confidence interval, HR = hazard ratio, LNM = lymph node metastasis, RAI = radioactive iodine.
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