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ORIGINAL RESEARCH

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Surgeon-performed fine-needle aspiration for lymph nodes behind the big cervical vessels in papillary thyroid cancer

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Abstract

Objective: This study aimed to describe the technique of surgeon-performed ultrasound (US)-guided fine-needle aspiration (FNA) of cervical retrovascular lymph nodes in papillary thyroid cancer (PTC) patients and analyze its efficacy.

Methods: This study included consecutive patients with retrovascular suspicious lymph nodes who had FNA performed by surgeons. The technique and efficacy of four different puncture routes were assessed.

Results: A total of 102 lymph node FNAs were performed on 100 patients. None yield insufficient aspiration, while 2% of FNA cytology result in an indeterminate diagnosis. No severe complication was observed. Cytologic testing plus thyroglobulin washout indicated sensitivity, specificity, positive predictive value, and negative predictive value in diagnosing nodal metastasis were 99%, 93%, 97%, and 97%, respectively. There was no significant difference in the test accuracy of FNA through different routes.

Conclusions: In PTC patients, suspicious lymph nodes behind the big cervical vessels should not be considered a contraindication to FNA. They can be diagnosed safely and accurately using appropriate puncture routes.

Level of evidence: 4.

KEYWORDS

fine-needle aspiration, papillary thyroid carcinoma, retrovascular lymph node, surgeon-performed, washout thyroglobulin

1 | INTRODUCTION

Papillary thyroid cancer (PTC) is the commonest endocrine malignancy, with a high tendency for cervical lymph node metastasis (LNM).[1] The incidence of regional neck disease ranging between 30% and 80%,[2] and LNM correlates with poor prognosis and recurrence.[3] Lymphadenopathy may manifest when thyroid cancer is diagnosed or may develop during postoperative follow-up. Confirmation of lymph node involvement is essential for decision-making regarding the implementation and extent of the surgery.

Fine-needle aspiration (FNA) is the first choice for cervical lymph node evaluation in patients with PTC.[3] FNA has a diagnostic sensitivity of 75% to 85% for detecting neck LNM in differentiated thyroid cancer (DTC) and analysis of thyroglobulin (Tg) concentration in the FNA washout (FNA-Tg) has been found to improve the accuracy. Early studies showed the sensitivity of FNA-Tg was up to 100%.[4,5]

The central neck is the most frequently involved region in DTC, followed by level IV and III in the lateral neck.[6] Lower deep cervical lymph nodes are found around the internal jugular vein and carotid artery, with some extending behind major vessels and connecting to the central compartment lymph nodes. Metastatic lymph nodes behind the jugular vein and carotid artery are not rare, but ultrasound (US)-guided FNA for these lymph nodes is challenging even for experienced practitioners. Hemorrhage and nondiagnostic aspirate obscured by blood are the main complications of concern,[7] and some radiologists may reject these patients if no other suspicious lymph node is available.

It has been shown that head and neck surgeons can perform FNA as well as skilled radiologists after training. Mastering this procedure by surgeons reduces the number of visits to different departments and creates a more comprehensive understanding of the extent of disease.[8–10] This study aims to describe the technique and analyze the efficacy of surgeon-performed US-guided FNA of cervical retrovascular lymph nodes in PTC patients.

2 | MATERIALS AND METHODS

2.1 | Patients

This retrospective study was approved by the Institutional Review Board of the Peking University Cancer Hospital (No. 2020KT106). From January 2019 to May 2021, 991 consecutive patients with suspected or confirmed thyroid cancer received US-guided FNA of cervical lymph nodes. The final population comprised 316 men and 675 women. The mean patient age was 42 years (15–81 years). Among them, we evaluated patients with target lymph nodes behind the jugular vein or carotid who underwent surgeon-performed FNA.

Before FNA, radiologists performed a neck ultrasound on all patients, assessing the central and lateral neck compartments for possible metastasis and recording the results. The criteria for prompting biopsy included: the maximum diameter ≥ 0.5 cm, hyperechogenicity, cystic changes, unbalanced inner echo, calcification, or a roughly round shape (long/transverse diameter ratio < 1.5).[11–13] Retrovascular lymph node was defined as the entire or most of the targeted lymph node between the medial margin of the common carotid artery and the lateral margin of the internal jugular vein. Computed tomography (CT) was not routinely performed before FNA, but it was recommended before subsequent neck dissection if the FNA result was positive. Patients with benign thyroid lesions or nonpapillary carcinoma were excluded. All procedures were performed by three experienced head and neck surgeons according to the location recorded by radiologists; the surgeries were carried out by the same surgeon who conducted the FNA. All patients provided informed consent before US-guided FNA.

2.2 | Operative technique

Each operation was performed by a single doctor. The patient was positioned supine, and the neck was sterilely prepared. The target node was localized in the center of the US monitor via a high-resolution ultrasound scanner (M9; Mindray, Shenzhen, China) with a 5 to 12 MHz linear probe. A single needle was required for each lymph node. The assay was performed with a 23- or 25-gauge needle (Hakko Co, Ltd. Nagano, Japan) attached to a 2 ml plastic syringe with or without an aspiration device. The aspirated material was directly smeared onto the glass slides and immersed immediately in 95% alcohol for staining. The residual material in the syringe was injected into the preserving fluid for liquid-based cytology. The same needle and syringe set were rinsed within 1 ml of normal saline to measure the washout Tg levels. Electrochemiluminescent immunoassay was utilized for the measurement of thyroglobulin from aspirates washout. After pulling the needle out, the nurse assistant held local press for about 10 to 20 s while the doctor processed specimens. Then, US examination was repeated to ensure no hematoma occurred. The patient was asked to stay in the hospital for at least half an hour under observation.

The needle entry point was along the long axis direction of the probe. There were four different needle paths employed according to the size and location of the target nodes (Video S1):

2.2.1 | Lateral to the internal jugular vein

The practitioner injected the tip of the needle several millimeters away from the lateral wall of the internal jugular vein. After perpendicularly introducing the needle tip to the level of the posterior wall of the internal jugular vein, the practitioner laterally angulated the needle toward the target and advanced the needle into the target lymph node (Figure 1A).

2.2.2 | Penetrating the internal jugular vein

In this approach, the needle entry point was usually at the medial side of the internal jugular vein. The wall of the jugular vein is soft and thin; after compressing the vessel with the US probe to block the blood flow, the practitioner directly punctured the major vessel and forwarded the needle into the target node (Figure 1B). The needle we used had a core in it, which was extracted after the tip of the needle entered the target node so that the blood would not fill the needle hub.

2.2.3 | Between common carotid artery and internal jugular vein

The needle entered obliquely, facing the space between the artery and vein. The needle was advanced into the target node once pushing away the vague nerve, closely adhered to the vessel wall (Figure 1C).

2.2.4 | Medial to the common carotid artery

After the ipsilateral thyroid gland has been resected, the carotid artery is usually close to the trachea. When the suspicious lymph nodes hide

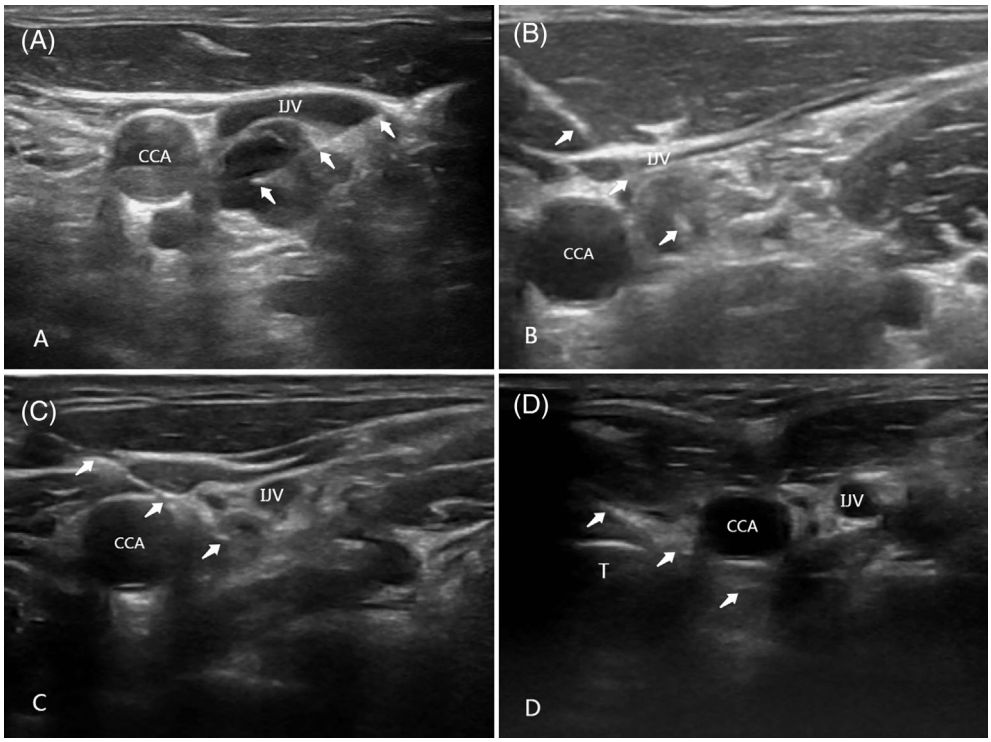

FIGURE 1 Four different puncture paths are illustrated on ultrasound imaging. (A) Lateral to the internal jugular vein; (B) penetrating the internal jugular vein; (C) between the common carotid artery and internal jugular vein, and (D) medial to the common carotid artery. CCA, common carotid artery; IJV, internal jugular vein; T, trachea; white arrow, needle tip, and path

behind the artery, the needle had to go over the trachea, breaking through the scar tissue between the trachea and the artery in a perpendicular direction to approach the target node (Figure 1D).

2.3 | Assessment of lymph node and the final diagnosis

Demographic information, anatomic features, cytopathologic results, and Tg washout level of biopsied lymph nodes were evaluated for this study. All the operation processes of FNAs were recorded as pictures or videos to confirm their locations and needle paths. As previously reported, a Tg washout concentration of 1 ng/ml was used as the cut-off value.[13] Cytopathologic and Tg test reports were obtained within 1–2 days. The data was used to finalize the surgical strategy. Lymph nodes with negative FNA results were kept under surveillance or excised for frozen section during thyroidectomy according to the preference of the operator.

2.4 | Statistical analysis

Descriptive statistics are reported as mean (range) for continuous variables and frequencies (percentage) for categorical variables. The sensitivity, specificity, positive and negative predictive values, the accuracy of FNA for retrovascular lymph nodes were calculated by comparing the FNA results with the final paraffin-embedded histopathological results. A malignant lymph node was defined as one that was resected and confirmed to be malignant by formal pathologic examination. A benign lymph node was defined as one that was confirmed by the paraffin-embedded pathologic report or that had no progression at follow-up. The Pearson X^2 test statistically evaluated the comparison of diagnostic efficacy among different puncture paths. Values of $p < 0.05$ were considered statistically significant. Data analyses were performed with SPSS for Windows (version 22.0, Chicago, IL).

3 | RESULTS

A total of 100 patients with PTC underwent 102 surgeon-performed US-guided FNAs of retrovascular lymph nodes. Two patients had two suspicious lymph nodes sampled on different sides. Seventy-four patients were female (74%). The mean age was 40.2 years (range: 18–65). The target lymph nodes were located on the left ($n = 53$) and right ($n = 49$). Mean lymph node size was 1.0 cm (range: 0.5–3.0). Seventy-nine of FNAs were performed concurrently with thyroid nodules workup, while the other 23 FNAs were performed during PTC follow-up after thyroidectomy. The ultrasound features of biopsied lymph nodes and puncture route selected were listed in Table 1. There were no complications with the procedure. Hematoma or adhesion was not found during subsequent operations.

Seventy patients had surgery after FNAC, and three had an excisional biopsy of the aspirated node during thyroidectomy. Fifty patients had neck dissections performed simultaneously with initial thyroidectomy, including one with bilateral neck dissection. Seventeen patients received recurrent neck dissection.

All lymph nodes showed adequate cytology in FNA samples. FNAs from 61 lymph nodes indicated metastasis from PTC (60%), and 39 showed benign findings (38%). In the two lymph nodes (2%), FNA cytologic testing was indeterminate, which had atypical cells and

could not be definitively diagnosed or exclude malignancy. Tg washout levels were available in all the lymph nodes and were found to be elevated (>1 ng/ml) in 71 (70%) cases.

The FNA cytology positive or Tg washout elevated was counted as FNA positive. According to this criteria, 73 (72%) lymph nodes showed positive results. Sixty-eight (93%) of the positive lymph nodes were excised, all were confirmed to be metastasis on surgical pathologic examination. Two patients with negative cytological results but elevated FNA-Tg refused surgery and had no progression or repeat FNA at a follow-up of 22 and 7 months. One patient with a positive cytologic result and negative FNA-Tg opted for radiofrequency ablation. Two patients were unavailable for follow-up. Of the remaining 29 lymph nodes with benign FNA results, one metastasis and two nonmetastases were confirmed by excisional biopsy during thyroidectomy. The other 26 lymph nodes had a median nonoperative follow-up of 23.5 (7–34) months and showed no signs of recurrence.

Excluding the patient who was unable to follow-up or had thermal ablation, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) in predicting lymph node metastasis were 99%, 93%, 97%, and 97% respectively. The overall accuracy of lymph node FNA was 97%. There was no significant difference in the performance of FNA among different puncture routes (Table 2).

TABLE 1 Anatomic, ultrasonographic features, and puncture routes of biopsied lymph nodes

Parameter	Count
Lymph node side, *n* (%)	
Left	53 (52)
Right	49 (48)
Lymph node size, cm, mean (range)	1.0 (0.5–3.0)
Lymph node ultrasound characteristics, *n* (%)	
Hypoechogenicity or unbalanced inner echo	92 (90)
Cystic changes	13 (13)
Calcification	30 (29)
Round shape	44 (43)
Puncture route, *n* (%)	
Lateral to the internal jugular vein	57 (56)
Penetrate the internal jugular vein	22 (22)
Between carotid and jugular vein	19 (19)
Medial to the carotid artery	4 (4)

4 | DISCUSSION

FNA is a widely accepted, rapid, and cost-effective method for diagnosing thyroid nodules and cervical lymph nodes. Lymph node FNA can be performed by surgeons, endocrinologists, or radiologists. Surgeons have several advantages over other specialists when performing ultrasound-guided lymph node FNAs: 1. More familiar with neck anatomy; 2. More experienced in managing complications; and 3. They obtain follow-up information through intraoperative positioning of the target nodes. Many patients with suspicious lymph nodes close to big cervical vessels were considered unsuitable for FNA by radiologists, and they were transferred to our department. Therefore, the proportion of lymph nodes located behind big vessels in all cervical lymph nodes is higher in this study compared with previous report.[14]

A postbiopsy hematoma is a primary concern for endocrinologists and radiologists when performing perivascular FNA in clinical practice. The reported hemorrhage or hematoma after thyroid FNA is 1.0–8.5% for small hematomas, while massive hematomas are rare.[15] There is limited data regarding the incidence of hematoma after cervical node FNA. One of the fundamental skills of performing neck

TABLE 2 Fine needle aspiration biopsy on different route and the test details

Puncture route	Lateral to the internal jugular vein	Penetrating the internal jugular vein	Between carotid and jugular vein	Medial to the carotid artery	Total	*p*
FNA cytologic results, *n* (%)						
Malignant	36 (63)	11 (50)	10 (53)	4 (100)	61 (60)	0.505
Benign	20 (35)	10 (45)	9 (47)	0 (0)	39 (38)	
Indeterminate	1 (2)	1 (5)	0 (0)	0 (0)	2 (2)	
FNA-Tg level, *n* (%)						
>1 ng/ml	42 (74)	13 (59)	12 (63)	4 (100)	71 (70)	0.294
≤1 ng/ml	15 (26)	9 (41)	7 (37)	0 (0)	31 (30)	
Performance of FNA to detect LNM						
Sensitivity	98%	100%	100%	100%	99%	0.875
Specificity	93%	100%	83%	–	93%	0.448
PPV	98%	100%	92%	100%	97%	0.610
NPV	93%	100%	100%	–	97%	0.617
Test accuracy	96%	100%	94%	100%	97%	0.720

Abbreviations: FNA, fine-needle aspiration; LNM, lymph node metastasis.

dissection for surgeons is the management of large vessels. Sometimes sacrifice or reconstruction of the internal jugular vein and carotid artery is needed when bulky cervical nodes involve them.[16,17] Small breaks or pinholes in the vessel wall can be closed automatically. Considering the relatively smaller diameter of the fine needle compared with other needles used in central venous catheterization through the jugular vein, hematoma should not be a common complication of concern.

Different needle entry points and routes can be selected according to the size, location of lymph nodes, and the preference of the practitioner. The approach lateral to the internal jugular vein is most commonly adapted for enlarged retrojugular lymph nodes, mainly when the short diameter of the node is close to or larger than the diameter of the internal jugular vein. Kim[14] first described this method in diagnosing retrojugular lymph nodes in the neck and observed no substantial complications related to the procedure. In our experience, it works in most cases. However, for some patients, the entry point of the needle should not be too lateral to avoid transient symptoms of brachial plexus irritation.

When the lymph nodes are small and close to the carotid artery, performing FNA by lateral approach can be difficult. In this situation, the approach of penetrating the wall of internal jugular vein provides an option. The jugular vein has a thin vessel wall and low blood pressure, and a biopsy can be performed directly by puncturing the vessel after compressing it with the US probe. Although the potential risk of inducing tumor seeding through the vessels has never been proven, it is noteworthy that this approach is only recommended for indolent malignancies like DTC.

The target lymph nodes between the common carotid artery and internal jugular vein can be aspirated through the intervascular approach to avoid puncturing the jugular vein. The vagus nerve can be seen in the puncture path on ultrasound, which could be easily pushed away to avoid injury. Vagus nerve injury was not occurred as per our experience.

The approach medial to the common carotid artery is often used for confirming the right paraesophageal lymph node (RPELN) recurrence. RPELN is located between the right recurrent laryngeal nerve and the prevertebral fascia. Surgeons often overlook dissection of RPELN, and recurrence in this area is not uncommon.[18] After the ipsilateral thyroid is resected, the carotid artery is dragged toward the trachea, making RPELN hide behind the artery. When the needle goes over the trachea and through the scar tissue between the trachea and the artery, the irritation to the trachea may cause a cough, implying that the needle should be more perpendicular. The recurrent laryngeal nerve is hard to identify on ultrasound. Fortunately, there was no recurrent laryngeal nerve injury during FNA in this study.

Despite the small size of retrovascular lymph nodes, US-guided FNA provided satisfactory adequacy and diagnostic accuracy. According to our recent research, in which all aspirated lymph nodes were resected and analyzed, when FNA cytology was combined with FNA-Tg, the sensitivity, specificity, PPV, NPV, and accuracy for predicting lateral neck metastasis were 85.6%, 90.1%, 96.4%, 66.7%, and 86.7%, respectively.[13] In another surgeon-performed US-guided lymph node FNA study with at least 6 months of follow-up as the standard of benign lymph node, the sensitivity and specificity in diagnosing nodal metastasis were 92% and 89%, respectively.[9] The reported sensitivity and specificity of retrovascular lymph nodes in the current study compared favorably with routine lymph nodes in the lateral neck. Therefore, the location of lymph nodes should not be an obstacle to the implementation of FNA in PTC patients.

The current study has some limitations. First, not all aspirated retrovascular lymph nodes were surgically confirmed, and the relatively short period of follow-up may have influenced the result due to the indolent nature of PTC. Second, an FNA-Tg concentration of >1 ng/ml was used as the cutoff value, according to our previous research in patients with intact thyroids. It is unknown whether this threshold applies to the lymph nodes adjacent to large blood vessels in postthyroidectomy patients. Finally, the small sample size in a single center may underestimate the incidence of complications, and a further multicenter investigation may be required to confirm the safety of this method.

5 | CONCLUSIONS

Suspicious metastatic lymph nodes behind the big cervical vessels should not be considered a contraindication of FNA in PTC patients. When surgeons operate through appropriate puncture routes, the target lymph nodes can be diagnosed safely and accurately.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

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