Cervical lymph node metastases in papillary thyroid cancer
Preoperative staging with ultrasound and/or computed tomography

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Abstract
Preoperative screening of potential risk of lymph node metastasis is necessary for thyroidectomy plus lymph node dissection. The 2015 American thyroid association management guidelines do not recommend prophylactic cervical lymph node resection without clinical evidence of metastasis. Ultrasound is recommended imaging method and routine computed tomography is not recommended by the 2015 American thyroid association management guidelines for screening of lymph node metastasis. The objective of the study was to compare the diagnostic performance of ultrasound against that of computed tomography for screening cervical lymph node metastasis of patients with papillary thyroid cancer before thyroidectomy plus lymph node dissection.

Data regarding preoperative neck ultrasound, neck computed tomography, and physical examination of the head and neck and postoperative pathological results of a total of 185 patients (age >18 years) with a diagnosis of papillary thyroid cancer who had suspicious lymph nodes on preoperative imaging and treated by thyroidectomy plus lymph node dissection for the therapeutic purpose were collected and analyzed.

Sensitivity (78.09% vs 75.28%, P < .0001) and accuracy (77.29% vs 75.13%, P = .0004) of neck computed tomography scanning to detect cervical lymph node metastasis were higher than those of neck ultrasound scanning. Sensitivity, accuracy, positive clinical utility, and negative clinical utility for neck ultrasound scanning plus neck computed tomography scanning to detect cervical lymph node metastasis were higher among all index tests (P < .05 for all) and were statistically the same as those of surgical pathology (P > .05 for all). The working areas for decision-making of thyroidectomy plus lymph node dissection of the physical examination, neck ultrasound, and the neck computed tomography, and the neck ultrasound scanning plus the neck computed tomography scanning were 0 to 0.691 diagnostic confidence/lesion, 0 to 0.961 diagnostic confidence/lesion, 0 to 0.944 diagnostic confidence/lesion, and 0 to 0.981 diagnostic confidence/lesion, respectively.

Besides the neck ultrasound, the neck computed tomography scanning can be used as a complementary imaging method to detect cervical lymph node metastasis of patients with papillary thyroid cancer before thyroidectomy plus lymph node dissection. Level of evidence: III.

Technical efficacy stage: 2.

Keywords: cervical lymph nodes metastasis, lymph node dissection, neck computed tomography, neck ultrasound, papillary thyroid cancer, thyroidectomy

1. Introduction
The incidence of thyroid cancer has increased in mainland China[1] particularly papillary thyroid carcinoma is more than 90% in the last few decades.[2] Lymph node metastasis has occurred in 60% to 70% of patients with papillary thyroid cancer[3] that is related to local recurrence and mortality.[4] There is the risk of loco-regional recurrence of about 15% to 30% in papillary thyroid cancer,[3] which needs appropriate preoperative screening of potential risk of lymph node metastasis for complete or partial thyroidecotmy plus lymph node dissection.[5,6] Also, the 2015 American thyroid association management guidelines[7] do not recommend prophylactic cervical lymph node resection without clinical evidence of metastasis.

Ultrasound is recommended imaging method for screening of lymph node metastasis in patients with papillary thyroid cancer before thyroidectomy plus lymph node dissection.[7] Also, ultrasound is superior to computed tomography for screening of benign or malignant nature of thyroid nodules.[8-9] However, ultrasound is operator-dependent, and retropharyngeal, retrosternal, and mediastinal regions are difficult to evaluate through
ultrasound.\textsuperscript{10,11} Also, the sensitivity of ultrasound is variable and low for central lymph node metastasis.\textsuperscript{12} Routine computed tomography is not recommended by the 2015 American thyroid association management guidelines,\textsuperscript{7} but computed tomography may use an adjunct to neck ultrasound to assess lymph node metastasis in patients with papillary thyroid cancer before thyroidectomy plus lymph node dissection.\textsuperscript{8} Computed tomography plays a complementary role in the assessment of lymph node metastasis before the surgical procedure.\textsuperscript{11} Unlike ultrasound, computed tomography is less operator-dependent and has a potential conclusion regarding lymph node metastasis around esophagus regions but has the risk of exposure to ionizing radiation and risk of future cancers is not addressed in available studies.\textsuperscript{14} Also, computed tomography has acceptable diagnostic performance for screening cervical lymph nodes metastasis before thyroidectomy plus lymph node dissection.\textsuperscript{15} Several pieces of research focused on the diagnostic value of computed tomography in cervical lymph nodes metastases in thyroid cancer and they also reported the sensitivity and specificity.\textsuperscript{16} Therefore, it is controversial to select a diagnostic modality for screening of cervical lymph node metastasis of patients with papillary thyroid cancer before thyroidectomy plus lymph node dissection.

The objective of the retrospective analysis of the cross-sectional study was to compare the diagnostic performance of neck ultrasound against computed tomography for screening cervical lymph node metastasis of patients with papillary thyroid cancer before thyroidectomy plus lymph node dissection.

The designed protocol (HaPH151421 dated March 1, 2021) was approved by the Haian People’s Hospital of Jiangsu Province review board and the Chinese Society of Clinical Oncology. The study reporting has adhered to the v2008 Declarations of Helsinki and the law of China. Being a retrospective study the registration in the Chinese Clinical Trial Registry was waived by the institutional review board. Also, neither patient approval nor informed consent was required for the study.

2. Materials and methods

2.1. Ethics approval and consent to participate

The objective of the retrospective analysis of the cross-sectional study was to compare the diagnostic performance of neck ultrasound against computed tomography for screening cervical lymph node metastasis of patients with papillary thyroid cancer before thyroidectomy plus lymph node dissection considering the results of surgical pathology as the reference standard.

2.2. Inclusion criteria

Patients (age > 18 years) with papillary thyroid cancer (positive in fine-needle aspiration cytology) underwent neck ultrasound and neck computed tomography scan before surgeries and who were treated by thyroidectomy plus lymph node dissection for treatment of cervical lymph nodes metastasis were included in the analysis. All patients of this study had suspicious lymph node metastasis on physical examination or imaging study. The authors did perform neck dissection for the therapeutic purpose in all.

2.3. Exclusion criteria

Patients whose complete data were not available at the patients’ records of the institutes and who were not treated by thyroidectomy plus lymph node dissection for treatment of cervical lymph nodes metastasis (because neck ultrasound and neck computed tomography scans showed free from metastasis) were excluded from the analysis.

2.4. Index test

2.4.1. Physical examination of the head and neck. It includes examinations of the size and firmness of the thyroid and any enlarged lymph nodes in the neck. In addition, laryngoscopy was performed to assess vocal cord motility.

2.4.2. Neck ultrasound scanning. Neck ultrasound was performed using an 8 to 10 MHz linear transducer (GE Healthcare, Little Chalfont, England) by radiologists (minimum of 5-years’ experience in thyroid imaging). The entire thyroid gland and cervical lymph node bearing area were examined. When the lymph node was reported enlarged, rounded, loss of fatty hilum, marked hypoechogenicity, abnormal vascularity, microcalcifications, or cystic change, then it was considered as cervical lymph nodes metastasis.\textsuperscript{11} The representative figure of neck ultrasound scanning is presented in Figure 1.

2.4.3. Neck computed tomography scanning. Neck computed tomography scanning was performed by the 40-slice scanner (Siemens Somatom Sensation, Siemens AG, Berlin, Germany). A total of 65 mL iohexol (Omnipaque, GE Healthcare, Little Chalfont, England) was given at a rate of 1.2 mL/s. After 60 seconds, using a 1.2 mm collimator and at 0.75 pitch scanning was performed. Images were acquired at 120 kVp and 1.5 mm axial plane slice thickness, from the skull base to the upper mediastinum. The images were reconstructed into 3.0mm axial × 3.0 coronal images. Neck computed tomography scanning was performed by radiologists (minimum of 5-years’ experience in head and neck imaging). In computed tomography

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{The representative figure of neck ultrasound scanning. A. Enlarged lymph node. A white circle indicates 1.06 cm of the lymph node in the axial plane. B. Marked hypoechogenicity. A white circle indicates hypoechogenicity of the lymph node. C. Microcalcifications. A white circle indicates calcification in the lymph node.}
\end{figure}
images, lymph nodes were examined for size, asymmetry, calcification, marked hypoattenuation, and cystic change, if it was reported any of suspicious parameter, then it was considered as cervical lymph nodes metastasis. The representative figure of neck computed tomography scanning is presented in Figure 2. The computed tomography was performed as a routine or after clinical findings. The details of image analysis for cervical lymph nodes metastasis of neck ultrasound and computed tomography scans are presented in Table 1. All imaging studies were retrospectively reviewed. Images can meet only 1 of the criteria for cervical lymph node metastasis.

2.4.4. Surgery. Thyroidectomy plus lymph node dissection was performed within 6-months from diagnostic imaging if neck ultrasound and/or neck computed tomography scans showed lymph nodes metastasis in any 1 cervical compartment out of 4 compartments (2 the central neck nodal and 2 the lateral neck nodal compartments defined as per recent American Thyroid Association consensus statement). Also, in a few cases, lymph nodes were removed for prophylactic purposes because patients may have changes of disease(s) progression (surgeons’ opinion). The cytological detection of lymph node metastases outside the central compartment will imply total thyroidectomy and ipsilateral systematic lymph node dissection of the affected lateral cervical compartment, otherwise the preferred treatment for small cancers is hemithyroidectomy. The resected surgical specimen of the thyroid plus lymph node was sent to the pathological laboratory for analysis.

2.4.5. Diagnostic parameters. Sensitivities, specificities, accuracies, positive clinical utility, and negative clinical utility of index tests for detection of cervical lymph node metastasis were calculated as per Eqs. 1, 2, 3, 4, and 5, respectively.

\[
\text{Sensitivity} = \frac{\text{True positives}}{\text{True positives} + \text{False negatives} + \text{Inconclusive results}} \times 100
\]  

(1)

\[
\text{Specificity} = \frac{\text{True negatives}}{\text{True negatives} + \text{False positives} + \text{Inconclusive results}} \times 100
\]  

(2)

\[
\text{Accuracy} = \frac{\text{True positives} + \text{True negatives}}{\text{True positives} + \text{True negatives} + \text{False positives} + \text{False negatives} + \text{Inconclusive results}} \times 100
\]  

(3)

\[
\text{Positive clinical utility} = \text{Sensitivity} \times \text{Positive predictive value}
\]  

(4)

\[
\text{Negative clinical utility} = \text{Specificity} \times \text{Negative predictive value}
\]  

(5)

Where,
True positives: Detected by individual index test and detected by surgical pathology.
True negatives: Not detected by individual index test and not detected by surgical pathology.
False positives: Detected by individual index test but not detected by surgical pathology.
False negatives: Not detected by individual index test but detected by surgical pathology.
Inconclusive results: No interpretation(s) due to poor image quality.

2.4.6. Clinical usefulness. The beneficial score was evaluated for each index test for decision-making of thyroidectomy plus lymph node dissection as per Eq. 6.

\[
\text{Beneficial score} = \frac{\text{True positive cervical lymph node metastasis}}{\text{Total numbers of cervical lymph node evaluated}} - \left( \frac{\text{False-positive cervical lymph node metastasis}}{\text{Total numbers of cervical lymph node evaluated}} \right) \times
\]

Level of diagnostic confidence above which the decision of thyroidectomy plus lymph node dissection was taken

\[
1 - \text{Level of diagnostic confidence above which the decision of thyroidectomy plus lymph node dissection was taken}
\]  

(6)
2.5. Statistical analysis

SPSS 26.0, IBM Corporation, Armonk, NY was used for statistical analysis purposes. A Chi-square test was performed between categorical variables. All results were considered significant at a 95% confidence level.

3. Results

3.1. Study population

From January 15, 2018 to January 1, 2020, a total of 250 patients with papillary thyroid cancer (had positive results with fine-needle aspiration cytopathology; Bethesda V or VI) underwent preoperative neck ultrasound and neck computed tomography scan at the department of ultrasound of the Haian People’s Hospital of Jiangsu Province, Haian, Jiangsu, China and the referring hospitals. Among them, neck ultrasound and neck computed tomography scans of 50 patients showed free from cervical lymph nodes metastasis and complete data of 13 patients were not available at the patients’ records of the institutes. Therefore, data of 65 patients were excluded from the analysis. Data regarding preoperative neck ultrasound, neck computed tomography, and physical examination of the head and neck and postoperative pathological results of a total of 185 patients (age > 18 years) with papillary thyroid cancer whose neck ultrasound and/or neck computed tomography scans have shown cervical lymph node metastasis in any 1 cervical compartment out of 4 compartments and treated by thyroidectomy plus lymph node dissection were collected from the patients’ records of the institutes and analyzed. The flow diagram of the retrospective analysis is reported in Figure 3. All of the 50 excluded scan negative cases were followed up clinically to show that there were no false negatives.

3.2. Characteristics of patients

Among enrolled patients 134 (72%) were female and 51 (28%) were male. Age and ethnicity of the enrolled patients are reported in Table 2.

3.3. Diagnostic parameters

True positive, false negative, inconclusive results, positive predictive value, and negative predictive value for physical

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Table 1

| Criteria for cervical lymph node metastasis of neck ultrasound and computed tomography scans. |
|-----------------------------------------------|
| Neck ultrasound | Neck computed tomography |
| Enlarged (>1 cm in axial plane) | Enlarged (>1 cm in transverse plane) |
| Rounded | Rounded |
| Loss of fatty hilum | Loss of fatty hilum |
| Marked hypoechoigenicity | Marked hypotenuation |
| Microcalcifications | Microcalcifications |
| Cystic change | Cystic change |

The size was not only used for decision-making of upper level 2 lymph node.

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Figure 3. The flow diagram of the retrospective analysis.
examination of the head and neck, neck ultrasound scanning, and neck computed tomography scanning to detect cervical lymph nodes metastasis were significantly fewer than those of surgical pathology ($P < .05$ for all). There were no significant differences between results of diagnostic parameters (true positive, false positive, true negative, false negative, inconclusive results, positive predictive value, and negative predictive value) for neck ultrasound scanning plus neck computed tomography scanning to detect cervical lymph nodes metastasis and those of surgical pathology ($P > .05$ for all). Also, there were no significant differences between the results of diagnostic parameters (true positive, false positive, true negative, false negative, inconclusive results, positive predictive value, and negative predictive value) for neck ultrasound scanning to detect cervical lymph nodes metastasis and those of neck computed tomography scanning. Inconclusive results (8 vs 12) and false negative values (31 vs 32) of neck computed tomography scanning to detect cervical lymph nodes metastasis were fewer than those of neck ultrasound but values were not statistically significant ($P > .05$ for both). The details of the diagnostic parameters of the index tests for detection of cervical lymph node metastasis are reported in Table 3.

Sensitivity, specificity, accuracy, and positive clinical utility for physical examination of the head and neck, neck ultrasound scanning, and neck computed tomography scanning to detect cervical lymph node metastasis were significantly fewer than those of surgical pathology ($P < .05$ for all). The sensitivity ($P < .0001$) and accuracy ($P = .0004$) of neck computed tomography scanning to detect cervical lymph node metastasis were significantly higher than those of neck ultrasound scanning. The specificity and positive clinical utility of neck computed tomography scanning to detect cervical lymph node metastasis were higher than those of neck ultrasound scanning but values were not statistically significant ($P > .05$ for both). The negative clinical utility of neck computed tomography scanning to detect cervical lymph node metastasis was the same as that of neck ultrasound scanning. Sensitivity, specificity, accuracy, positive clinical utility, and negative clinical utility for neck ultrasound scanning plus neck computed tomography scanning to detect cervical lymph node metastasis were higher among all index tests ($P < .05$ for all). Sensitivity, accuracy, positive clinical utility, and negative clinical utility for neck ultrasound scanning plus neck computed tomography scanning to detect cervical lymph node metastasis were statistically the same as those of surgical pathology ($P > .05$ for all). However, specificity for neck ultrasound scanning plus neck computed tomography scanning to detect cervical lymph node metastasis was fewer than that of

### Table 2
Demographical, anthropological, and surgical characteristics of patients.

| Characteristics                                      | Value       |
|------------------------------------------------------|-------------|
| The numbers of patients included in the analysis     | 185         |
| Sex                                                  |             |
| Male                                                 | 51 (28)     |
| Female                                               | 134 (72)    |
| Age (yrs)                                            |             |
| Minimum                                              | 23          |
| Maximum                                              | 68          |
| Mean ± SD                                            | 42.15 ± 9.15|
| Ethnicity                                            |             |
| Han Chinese                                          | 170 (92)    |
| Mongolian                                            | 13 (7)      |
| Tibetan                                              | 2 (1)       |
| Family history of papillary thyroid cancer            |             |
|                                                      | 45 (24)     |
| The extent of lymph nodes dissection                 |             |
| One side of the central cervical compartment         | 143 (77)    |
| Both sides of the central cervical compartment        | 27 (15)     |
| Both sides of the central cervical compartment with the lateral cervical compartment | 15 (8) |

Categorical variables are demonstrated as frequency (percentages) and continuous variables are demonstrated as mean ± standard deviation (SD).

### Table 3
Diagnostic parameters of the index tests for detection of cervical lymph node metastasis.

| Parameters                      | Surgical pathology | Physical examination of the head and neck | Neck ultrasound scanning | Neck computed tomography scanning | Neck ultrasound scanning + Neck computed tomography scanning |
|---------------------------------|--------------------|------------------------------------------|--------------------------|-----------------------------------|-------------------------------------------------------------|
| Patients                        | 185                | 185                                      | 185                      | 185                               | 185                                                         |
| True positive                   | 179 (97)           | 56 (30)                                  | <.0001                   | 134 (73)                          | 139 (75)                                                   | <.0001                                                      | .636                                                        | 177 (96)                                                   | .785                                                        |
| False positive                  | 0 (0)              | 25 (13)                                  | <.0001                   | 2 (1)                             | 3 (2)                                                      | .478                                                        | .258                                                        | .653                                                        | .478                                                        |
| True negative                   | 6 (3)              | 1 (1)                                    | .127                     | 5 (3)                             | 4 (2)                                                      | .759                                                        | .749                                                        | .736                                                        | .759                                                        |
| False negative                  | 0 (0)              | 72 (39)                                  | <.0001                   | 32 (17)                           | 31 (17)                                                    | <.0001                                                      | .890                                                        | 1 (1)                                                      | .127                                                        |
| Inconclusive results            | 0 (0)              | 31 (17)                                  | <.0001                   | 12 (6)                            | 8 (4)                                                      | .012                                                        | .491                                                        | 0 (0)                                                      | N/A                                                         |
| Positive predictive value       | 179 (97)           | 81 (43)                                  | <.0001                   | 136 (74)                          | 142 (77)                                                   | <.0001                                                      | .548                                                        | 179 (97)                                                   | .999                                                        |
| Negative predictive value       | 6 (3)              | 73 (40)                                  | <.0001                   | 37 (20)                           | 35 (19)                                                    | <.0001                                                      | .896                                                        | 6 (3)                                                      | .999                                                        |

Data are presented as frequencies (percentages).

A Chi-square test was performed for statistical analysis.

A $P$ value less than .05 was considered significant.

N/A = not applicable.

* Concerning surgical pathology.

† Concerning neck ultrasound scanning.
surgical pathology \( (P < .0001) \). The details of sensitivity, specificity, accuracy, positive clinical utility, and negative clinical utility to detect cervical lymph node metastasis of different index tests are reported in Table 4.

### 3.4. Clinical usefulness

The working area for decision-making of thyroidectomy plus lymph node dissection for surgical pathology was 0 to 1 diagnostic confidence/lesion. That for the physical examination of the head and neck was 0 to 0.691 diagnostic confidence/lesion. That for the neck ultrasound scanning was 0 to 0.961 diagnostic confidence/lesion. That for the neck computed tomography scanning was 0 to 0.944 diagnostic confidence/lesion and for the neck ultrasound scanning plus the neck computed tomography scanning, the working area was 0 to 0.981 diagnostic confidence/lesion. Above 0.691, 0.961, and 0.944 diagnostic confidence/lesion, the physical examination of the head and neck, the neck ultrasound scanning, and the neck computed tomography scanning had the risk of overdiagnosis. However, the neck ultrasound scanning plus the neck computed tomography scanning had the least risk of overdiagnosis (above 0.981 diagnostic confidence/lesion). The details of beneficial score analyses are reported in Figure 4 and Table 5.

### 4. Discussion

Sensitivity and accuracy of neck computed tomography to detect cervical lymph node metastasis were superior than those of neck ultrasound. In contrast, all the diagnostic parameters of the neck

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**Table 4**

| Diagnostic parameters | Surgical pathology Value | Physical examination of the head and neck Value | Neck ultrasound scanning Value | Neck computed tomography scanning Value | Neck ultrasound scanning + neck computed tomography scanning Value |
|-----------------------|--------------------------|---------------------------------------------|--------------------------------|----------------------------------------|---------------------------------------------------------------|
| Sensitivity           | 100%                     | 35.22% < .0001                              | 75.28% < .0001                | 78.09% < .0001                        | 99.44% .316                                                  |
| Specificity           | 100%                     | 1.75% < .0001                              | 26.31% < .0001                | 26.67% < .0001                        | 71.43% < .0001                                              |
| Accuracy              | 100%                     | 37.01% < .0001                              | 75.13% < .0001                | 77.29% < .0001                        | 98.38% .477                                                  |
| Positive clinical utility | 0.97                    | 0.15 < .0001                               | 0.56 < .0001                  | 0.60 < .0001                          | 0.96 .701                                                   |
| Negative clinical utility | 0.03                    | 0.007 .0003                               | 0.05 .718                    | 0.05 .718 N/A                         | 0.02 .651                                                   |

A Chi-square test was performed for statistical analysis.
A \( P \) value less than .05 was considered significant.
N/A = not applicable.
\* Concerning surgical pathology.
\† Concerning neck ultrasound scanning.

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**Figure 4.** Beneficial score analysis for index test for decision-making of thyroidectomy plus lymph node dissection.
ultrasound scanning plus the neck computed tomography scanning was far superior to neck ultrasound alone. The results of the diagnostic performance of the current study are consistent with those of prospective studies and meta-analyses. Computed tomography is less operator-dependent, the retropharyngeal, retrosternal, and mediastinal areas of lymph nodes are possible to evaluate with computed tomography, and it provides the view of the skull to the mediastinum. Neck ultrasonosonography provides information for sensitive focal lesions and it is difficult to evaluate the entire neck by ultrasound. At the same time, neck computed tomography provides information for a high-resolution image of the lesion concerning the surrounding cervical viscera. Unavailability of the entire neck for diagnosis is resulted in a higher rate of detection of false-negative cervical lymph node metastasis by neck ultrasound scanning. Quality of ultrasound images were poor because of an 8–10 MHz transducer used. Modern sonography of the head and neck uses between 12–16 MHz transducer. This (8–10 MHz transducer) was a factor in reducing ultrasound sensitivity. Neck computed tomography to detect cervical lymph node metastasis has the supporting role in the planning of thyroidectomy plus lymph node dissection but the major trade-off is radiation dose and the use of iodinated contrast for which might delay the iodine ablation treatment(s).

The current study was used it for neck computed tomography. Iohexol is iodine-based contrast material and it was strictly before thyroidectomy plus lymph node dissection. Body iodine is cleared within 1 to 2 months. Also, it is not a potential biomarker of thyroid ablation. The benefit of improved neck imaging usually outweighs any potential risk associated with a 1 to 2 months delay in radioactive iodine imaging or treatment(s).

In the index test, 200 (80%) patients out of 250 patients were reported cervical lymph node metastasis in the neck ultrasound and/or neck computed tomography scans. However, 81 (44%) patients out of 250 patients were reported cervical lymph nodes metastasis in the physical examination of the head and neck. The result of the prevalence of cervical lymph node metastasis of the current study is consistent with those of prospective and retrospective studies. The prevalence of cervical lymph node metastasis among patients with papillary thyroid cancer is 30% to 80%. The physical examination of the head and neck provided little information for decision-making of thyroidectomy plus lymph node dissection.

Neck ultrasound and neck computed tomography both reported false positive and false negative values. Neck ultrasound and neck computed tomography both had poor sensitivity and specificity in the central neck compartments. Also, ultrasound is operator-dependent and nodes smaller than 1 cm and near to the mandible are mostly missed by ultrasound. Not all metastatic nodes from papillary carcinoma are “markedly hyperechoic”. In fact, some metastatic papillary Ca nodes are often hyperechoic compared to adjacent muscle. Radiologists with great expertise in thyroid imaging can rule out negative predictive values of imaging modalities.

The general concept of this research is very interesting and can be useful for clinical practice. However, there are certain points where the study has a limitation, for example, the retrospective study and lack of dynamic study. In the other limitations of the study, the experience of radiologists have an impact on the predictive values of imaging modalities. However, imaging modalities have different diagnostic parameters for different compartments of cervical lymph nodes. The inter-and intra-observer reliability was not evaluated in the study. Long-term outcomes were available since the study was a retrospective study. However, the study included the patients with complete data including neck computed tomography scan, ultrasound scan, and pathological diagnosis, which is necessary to calculate the accuracy. In contrast, this criterion has ruled out those patients not examined by neck computed tomography scan or ultrasound thus missing the cervical lymph nodes dissection (n = 50). These patients are essentially important when the study is trying to differentiate the indolent nodules from the aggressive ones. Severe bias will be brought in the evaluation of the diagnostic tests and the accuracy is elevated unintentionally. Comparison of these points with the surgical or long-term outcome would be significant. The study has extremely high (24%) positive family history compared to other series.

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**Table 5**

| Level of diagnostic confidence above which the decision of thyroidectomy plus lymph node dissection was taken | Surgical pathology | Physical examination of the head and neck | Neck ultrasound scanning | Neck computed tomography scanning | Neck ultrasound scanning + neck computed tomography scanning |
|---|---|---|---|---|---|
| 0 | 0.967567 | 0.302703 | 0.724324 | 0.751351 | 0.956757 |
| 0.1 | 0.967567 | 0.287688 | 0.723123 | 0.74955 | 0.955556 |
| 0.2 | 0.967567 | 0.268919 | 0.721622 | 0.747297 | 0.954054 |
| 0.3 | 0.967567 | 0.244788 | 0.719691 | 0.744402 | 0.952124 |
| 0.4 | 0.967567 | 0.212613 | 0.717117 | 0.740541 | 0.94955 |
| 0.5 | 0.967567 | 0.167568 | 0.713514 | 0.735135 | 0.945946 |
| 0.6 | 0.967567 | 0.1 | 0.708108 | 0.727027 | 0.940541 |
| 0.7 | 0.967567 | –0.01261 | 0.699099 | 0.713514 | 0.931532 |
| 0.8 | 0.967567 | –0.23784 | 0.681081 | 0.686486 | 0.913514 |
| 0.9 | 0.967567 | –0.91351 | 0.627027 | 0.605405 | 0.895496 |
| 0.99 | 0.967567 | –13.0757 | –0.34959 | –0.85405 | –0.11351 |
5. Conclusions

The current study has meticulously correlated ultrasound and computed tomography findings in cases of papillary thyroid cancer against surgical pathology in this evidence-level 3 diagnostic study at thornbury level 3, diagnostic impact. The optimal investigations for thyroid cancer are a topical subject and this study offers new knowledge. The physical examination of the head and neck provided little information for decision-making of thyroidectomy plus lymph node dissection. Only sensitivity and accuracy of neck computed tomography are superior to neck ultrasound. However, the diagnostic performance of neck ultrasound scanning plus the neck computed tomography scanning is superior to neck ultrasound alone to detect cervical lymph nodes metastasis of patients with papillary thyroid cancer. The neck computed tomography scanning can be used as a complementary method in addition to neck ultrasound to detect cervical lymph nodes metastasis of patients with papillary thyroid cancer. However, the risk of exposure to ionizing radiation, the rescheduling of patients for neck computed tomography, and possibly delay iodine ablation treatment for at least 1 to 2 months must be considered. The findings of this study are particularly novel or add significant new information in the field of papillary thyroid cancer.

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Conceptualization: Liang Chen.
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Resources: Liang Chen.
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Visualization: Liang Chen.
Writing – original draft: Guiling Lu.
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