Preoperative staging of papillary thyroid carcinoma: Comparison of ultrasonography and computed tomography

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Directed by Professor Eun-Kyung Kim

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Written by Ji Soo Choi

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ABSTRACT

Preoperative staging of papillary thyroid carcinoma : Comparison of ultrasonography and computed tomography

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Objective. To compare the diagnostic accuracies of ultrasonography (US) and computed tomography (CT) for preoperative evaluation of primary tumors and cervical lymph nodes in patients with papillary thyroid carcinoma (PTC), and to determine whether CT provides additional diagnostic value compared to US alone in these patients.

Materials and Methods. The study population consisted of 299 consecutive patients with pathologically proven PTC. We assessed the diagnostic accuracies of US, CT, and combined US and CT [US/CT] for the evaluation of primary tumors and lymph node metastasis. We performed subgroup analysis to compare papillary thyroid microcarcinomas (PTMC, 10 mm or

less in maximum diameter) with PTC greater than 1 cm in maximum diameter.

Results. US predicted extrathyroidal tumor extension and bilateral thyroid lobe malignancy more accurately than CT ($p<0.05$) for overall lesions as well as for the 2 subgroups. For predicting central node (Ⅵ) metastasis, CT showed higher sensitivity than US alone ($p=0.040$) for overall lesions. Although US/CT showed higher sensitivity compared to US alone in predicting central node metastases for the 2 subgroups, US/CT did not reach statistical significance in sensitivity for PTMC. US alone and US/CT showed higher sensitivity than CT in predicting lateral node (levels Ⅱ to Ⅴ) metastasis, however, there was no significant difference in diagnostic values between US and US/CT for overall lesions or for the 2 subgroups ($p>0.05$).

Conclusions. High-resolution US can provide an accurate preoperative evaluation of extrathyroidal tumor extension and lateral lymph node metastasis. CT showed higher sensitivity than US alone in detecting central lymph node metastasis for overall lesions. For PTMC, however, there was no significant difference in diagnostic accuracy between US, CT, and US/CT.

Key words: ultrasonography, CT, papillary thyroid carcinoma, preoperative

Preoperative staging of papillary thyroid carcinoma : Comparison of ultrasonography and computed tomography

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I. INTRODUCTION

Ultrasonography (US) is widely used for preoperative imaging of papillary thyroid carcinoma (PTC). High-resolution US can detect lymph node metastases as small as 5 mm[1,2] and can therefore influence the extent of surgery[1,3,4]. When US detects a suspicious lymph node, US-guided needle aspiration biopsy can be performed immediately, and in that same procedure[5]. As Park et al. recently showed, US performs well in preoperative staging of the extent of primary tumors and lymph node metastasis in PTC[6].

Management guidelines of the American Thyroid Association recommend preoperative neck US for patients with differentiated thyroid cancer[7]. Computed tomography (CT) is the preferred method to stage head and neck cancer because it can assess the location and extent of the primary tumor (or invasion of adjacent structures) and the probability that lymph node metastasis has occurred[8]. However, few studies have examined the use of CT to evaluate PTC[1,3,9,10], which shows a quite different disease manifestation and much better prognosis than the more common squamous cell carcinomas of the head and neck. A recent study on lymph node metastasis detection in PTC reported that combined US and CT was superior to US alone, but no significant difference was observed between US and CT[10]. Few studies have compared the diagnostic accuracy of US and CT for preoperative detection of cervical lymph node metastasis in patients with PTC, and no study has compared these two imaging techniques for T staging of primary tumors.

We therefore conducted this study to compare the diagnostic accuracies of US and CT in preoperative evaluation of primary tumors and cervical lymph nodes in patients with PTC, and determined whether CT can provide additional diagnostic value compared to US alone in these patients.

II. MATERIALS AND METHODS

1. Subjects

This study included 299 patients who were surgically diagnosed with PTC from February 2006 to April 2007. None of these patients (255 women and 44 men; age range, 20-74 years [mean, 45 years]) underwent previous head or neck surgeries, and all had received US and contrast-enhanced CT evaluations before surgery. Our institutional review board approved this retrospective study, and waived the informed consent requirement.

2. Ultrasonography

US examinations were performed prospectively by one of three radiologists with 8-12 years of experience and specialized in thyroid US. The radiologists knew of the cytological confirmation of malignancy in the thyroid masses at the time US was performed for tumor staging. US examinations included both thyroid lobes and all neck levels (levels Ⅰ to Ⅵ). Thyroid US was performed using a 5-12-MHz linear transducer (iU22; Philips Medical Systems, Bothell, WA), or a 7-15-MHz linear transducer (HDI 5000; Philips Medical Systems, Bothell, WA).

3. Neck CT

Contrast-enhanced CT scans were obtained in all patients using multi-detector row CT scanners (Somatom Sensation 16 or Somatom Sensation 64; Siemens, Erlangen, Germany) with a reconstructed slice thickness of 3 mm for axial and coronal images. A 90 mL dose of iodinated contrast medium (Ultravist 300; Bayer Schering Pharma, Berlin, Germany) was administered intravenously at a rate of 3 mL/s with an automated injector. A normal saline flush was injected at 3 mL/s immediately after administration of the contrast medium to reduce artifacts induced within the subclavian vein. The scan delay time was 40-60 seconds.

4. Image analysis

Preoperative staging of the primary tumor (T) and regional lymph nodes (N) using US and CT was performed in accordance with the TNM classification of the American Joint Committee on Cancer and the International Union Against Cancer Committee (AJCC/UICC)[11] (Table 1). Bilaterality and multiplicity of thyroid nodules were also evaluated. Bilaterality was defined by observation of multiple PTCs in both thyroid lobes, and multiplicity was defined as multiple PTCs in one lobe.

Table 1. T and N Staging in the 6th Edition of the AJCC/UICC (2002)

Category	Definition
Primary tumor (T)	
TX	Primary tumor cannot be assessed
T0	No evidence of primary tumor
T1	Tumor 2 cm or less in its greatest dimension, limited to the thyroid
T2	Tumor more than 2 cm, but not more than 4 cm in its greatest dimension, limited to the thyroid
T3	Tumor more than 4 cm in its greatest dimension, limited to the thyroid, or any tumor with minimal extrathyroidal extension (e.g., extension to sternothyroid muscle or perithyroid soft tissues)
T4a	Tumor of any size extending beyond the thyroid capsule to invade subcutaneous soft tissues, larynx, trachea, esophagus, or recurrent laryngeal nerve
T4b	Tumor invades prevertebral fascia or encases carotid artery or mediastinal vessels
Regional lymph nodes (N)	
NX	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastasis
N1	Regional lymph node metastasis
N1a	Metastasis to level VI (pretracheal, paratracheal, or prelaryngeal/Delphian lymph nodes)
N1b	Metastasis to unilateral, bilateral, or contralateral cervical or superior mediastinal lymph nodes

Depending on the size of the tumor, we stratified patients into two groups. Those with papillary thyroid microcarcinoma (PTMC, 186 patients) had tumors 10 mm or less in maximum diameter; and those with PTC (113 patients) had tumors more than 1 cm in maximum diameter.

Size of tumors, extrathyroidal extensions, and invasion of adjacent structures were evaluated for T staging. The ultrasound criterion for extrathyroidal extension were as follows: loss of echogenic thyroid capsule at the contact site of the primary tumor (i.e., with no thyroid tissue intervening between the primary tumor and capsule), and contact with the adjacent thyroid capsule along more than 25% of the perimeter of the tumor[12]. If multiple malignant lesions were present, the most extensive tumor had priority in T staging. N staging was based on compartments rather than individual levels, including the left and right lateral compartments (levels Ⅱ to Ⅴ) and the central compartment (level Ⅵ). The US criterion for lymph node metastasis were as follows: focal or diffuse hyperechogenicity, microcalcification, cystic change, minor axis greater than 10 mm, minor axis greater than 50% of major axis, and abnormal vascular pattern (chaotic or peripheral)[13-15].

One head and neck radiologist, who knew the cytological results of the thyroid malignancy but was blind to the surgical diagnosis and US findings, interpreted the CT images retrospectively. When the primary tumor showed

capsular abutment more than 25% of the tumor's perimeter, it was considered to have extrathyroidal extension. If the thyroid nodules were too small to appear on CT scans, the T stage was classified as Tx. In CT, N staging was based on the compartment approach used for US evaluations. Lymph nodes were classified as metastatic lymph nodes based any of the following criteria: calcification, cystic or necrotic change, heterogeneous enhancement, and strong enhancement without hilar vessel enhancement[10,16].

5. Surgical procedures

Two hundred-twelve patients underwent total or near-total thyroidectomies. Ipsilateral lobectomy with contralateral subtotal lobectomy was performed on 87 patients. All patients underwent central compartment dissection. Lateral compartment dissection was selectively performed in patients with preoperative N1b stage nodes or patients at high risk. Surgeons dissected all visible or palpable lymph nodes using a compartment-oriented approach, in view of preoperative US and CT findings. Of 299 dissected central compartments, 111 central compartments were pathologically proven to have metastatic nodes. Lateral compartment dissection was performed on 53 compartments in 50 patients, including unilateral dissection in 47 patients, and bilateral dissection in 3 patients. Lymph nodes with metastasis were found in

49 of 53 lateral compartments dissected.

6. Statistics

The final status of T or N staging was based on pathological interpretations of surgical specimens. Diagnostic accuracies of US and CT for preoperative T staging were analyzed. Because presence of extrathyroidal extension affects the extent of surgery, pathologic T stages were grouped into more clinically relevant stages, i.e., with (T3, T4) or without (T1, T2) extrathyroidal extension. 'Accurate staging' therefore meant that a preoperative T1 or T2 stage was assigned by pathology to the same group, and a T3 or T4 stage to the same group. In 'overstaging,' a preoperative T3 or T4 stage was finally assigned to a low-grade group; and in 'understaging,' a preoperative T1 or T2 was assigned to a high-grade group. In this analysis, a preoperative Tx stage was equivalent to T1. We used the chi-square test to compare the accuracy of US and CT in preoperative T staging of all lesions, and for each of the two groups individually.

In the analysis of preoperative N staging, the diagnostic performances of US and CT were defined in terms of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy for predicting the presence of metastases by a compartment-oriented analysis. Surgically

dissected compartments (central n=299, lateral n=53) were only included for statistical analysis. Diagnostic performance of combined US and CT [US/CT] was also calculated. Chi-square test and Fischer's exact test were used to compare sensitivities and specificities of US, CT, and US/CT for detection of nodal metastases in all lesions and for each of the two groups, respectively.

For all tests, we considered a *p* value less than 0.05 to indicate a statistically significant difference.

III. RESULTS

Final T and N stages of PTC based on surgery are shown in Table 2. Among 299 patients, T1 was pathologically confirmed in 126 patients, T2 in 6 patients, T3 in 166 patients, and T4a in 1 patient. PTMC was confirmed in 186 patients.

Table 2. Final T and N Stage Confirmed by Surgery.

Final stage		<2cm	2-4cm	>4cm	All lesions
T stage	T1	126	0	0	126
	T2	0	6	0	6
	T3	140	25	1	166
	T4a	0	0	1	1
N stage	N0	171	9	0	180
	N1a	61	9	1	71
	N1b	34	13	1	48
	Total	266	31	2	299

<2 cm: tumor less than 2 cm in maximum diameter; 2-4 cm: more than 2cm and under 4 cm; >4 cm: tumor more than 4 cm

1. Multiplicity and bilaterality

Pathologically, bilateral malignancy was found in 69 patients (23%), and multiple carcinomas in 107 patients (36%). Sensitivities and positive prognostic values (PPV) for bilaterality and multiplicity based on US and CT are shown in Table 3. Preoperative US showed higher sensitivity and PPV than did CT for bilaterality (p<0.001). For multiplicity, preoperative US showed significantly higher PPV than did CT (p=0.0432), but the sensitivities of US and CT did not differ significantly in this study.

Table 3. Sensitivities and Positive Predictive Values for US and CT in Predicting Bilaterality and Multiplicity

Analysis	Modality	Sensitivity (%)	PPV (%)
Bilateral malignancy	US	60/69 (87.0)	60/60 (100.0)
	CT	34/69 (49.3)	34/80 (42.5)
	P value	<0.001*	<0.001*
Multiple carcinomas	US	64/107 (59.8)	64/94 (68.0)
	CT	58/107 (54.2)	58/102 (56.9)
	P value	0.490	0.0432*

US: ultrasound; CT: computed tomography; PPV: positive predictive value; *P*-values* are less than 0.05

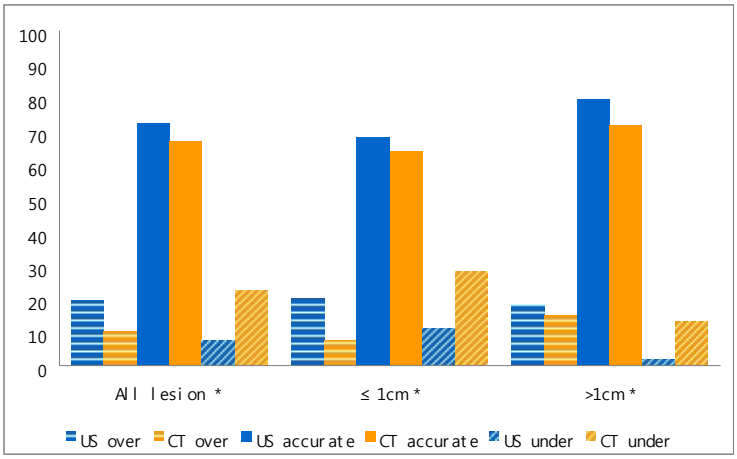
2. T staging

Figure 1 and Table 4 show diagnostic performances of US and CT for preoperative T staging. For overall lesions as well as subgroup analysis, accurate staging was significantly higher on US than CT ($p<0.01$, Fig. 2). Overstaging occurred more frequently with US and understaging more frequently with CT ($p<0.01$). Among the eight PTCs not visualized with CT (Tx), 7 were confirmed as T1, and one was confirmed as T3 due to extrathyroidal extension, which was accurately predicted as T3 with preoperative US (Fig. 3). One case was confirmed as T4a, which was a 5 cm-sized PTC with tracheal invasion. It was accurately predicted as T4a with CT but was determined as T3 by US.

Table 4. US and CT Stage Versus Pathologic T stage

	Pathologic Stage				
	T1	T2	T3	T4	Total
US Stage					
T1	72	0	22	0	94
T2	0	1	1	0	2
T3	54	4	139	1	198
T4	0	1	4	0	5
CT Stage					
Tx	7	0	1	0	8
T1	94	0	66	0	160
T2	0	0	1	0	1
T3	25	5	98	0	128
T4	0	1	0	1	2
Total	126	6	166	1	299

Figure 1. Preoperative T staging with US and CT. Staging accuracy was significantly higher with US than with CT in all lesions and subgroups.



≤ 1 cm: tumor 10 mm or less in maximum diameter; > 1 cm: tumor more than 10mm in maximum diameter; US: Ultrasound; CT: Computed Tomography; over: overstaging; accurate: accurate staging; under: understaging; * $p<0.05$

Figure 2. A 35-year-old woman with papillary thyroid cancer (PTC) in the left lobe of the thyroid gland. Extrathyroidal extension with disruption of hyperechoic thyroid capsule (arrow) is observed on the transverse (A) ultrasound (US) image. However, extrathyroidal extension is not clearly seen on the axial (B) image by computed tomography (CT). Preoperative T stage of this tumor was determined as T3 with US, and as T1 with CT. The T stage was surgically confirmed as T3.

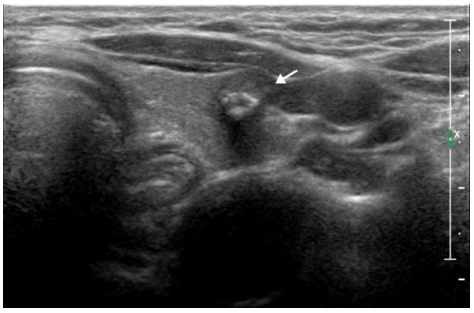
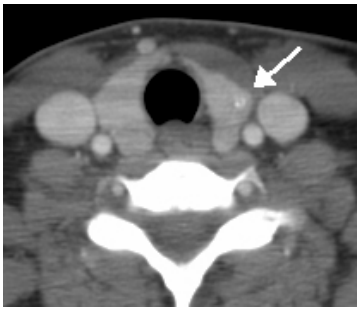
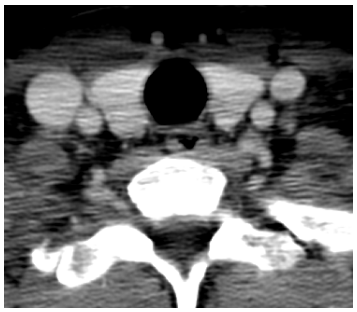
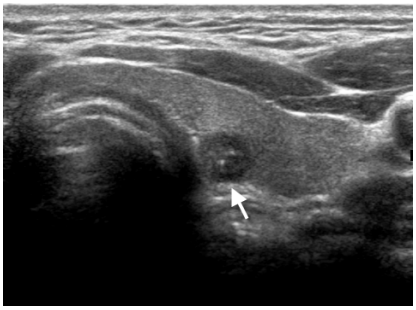
A.  B. 

Figure 3. A 35-year-old man with PTC in left lobe of the thyroid gland. The axial CT image (A) shows no visible lesion in the thyroid gland. However, the US image (B) shows a small PTC (6 mm) with more than 25% contact with the thyroid capsule, suggesting extrathyroidal extension (arrow) into the left lobe of the thyroid. Preoperative T stage of this tumor was determined as T1 with CT, and as T3 with US. The T stage was finally confirmed as T3 by surgery.

A.  B. 

3. N staging

Table 5 presents the diagnostic accuracies of US, CT, and US/CT for the detection of lymph node metastasis by the compartment-oriented approach. For overall lesions and both subgroups, US showed low sensitivity and high specificity in the central compartment (Ⅵ), but high sensitivity in the lateral compartment (levels Ⅱ to Ⅴ). US/CT had higher sensitivity, higher NPV, and lower specificity than CT or US in central and lateral compartments.

Statistical analysis for differences between sensitivities and specificities of each imaging modality are shown in Table 6. For the detection of lymph node metastasis in the central compartment, for all thyroid nodules, CT showed higher sensitivity than US (p=0.040), and US/CT showed higher sensitivity (p=0.002) and lower specificity than US alone (p=0.032). In lateral compartments, sensitivity of US/CT was significantly higher than that of CT (p=0.025), but the sensitivity did not differ significantly between US/CT and US alone. CT detected lymph node metastases not diagnosed by US in 22 central compartments (19.8%) and 1 lateral (1.8%, Fig. 4), while US detected lymph node metastases not diagnosed by CT in 7 central (6.3%) and 6 lateral compartments (11.3%, Fig. 5).

Table 5. Diagnostic Accuracies of US, CT, and US/CT in Detection of Lymph Node Metastasis

Analysis	Modality	Diagnostic Values				
		Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
All lesions						
Central compart-ments (n=299)	US	59/111 (53.2)	150/188 (79.8)	59/97 (60.8)	150/202 (74.3)	209/299 (69.9)
	CT	74/111 (66.7)	149/188 (79.3)	74/113 (65.5)	149/186 (80.1)	223/299 (74.6)
	US/CT	81/111 (73.0)	132/188 (70.2)	81/137 (59.1)	132/162 (81.5)	213/299 (71.2)
Lateral compart-ments (n= 53)	US	46/49 (93.9)	1/4 (25.0)	46/49 (93.9)	1/4 (25.0)	47/53 (88.7)
	CT	40/49 (81.7)	4/4 (100.0)	40/40 (100.0)	4/13 (30.8)	44/53 (83.1)
	US/CT	47/49 (95.9)	1/4 (25.0)	47/50 (94.0)	1/3 (33.3)	48/53 (90.6)
Primary tumor > 1cm						
Central compart-ments (n=113)	US	37/66 (56.1)	35/47 (74.5)	37/49 (75.5)	35/64 (54.7)	72/113 (63.7)
	CT	47/66 (71.2)	32/47 (68.1)	47/62 (75.8)	32/51 (62.8)	79/113 (69.9)
	US/CT	51/66 (77.3)	28/47 (59.6)	51/70 (72.9)	28/43 (65.1)	79/113 (69.9)
Lateral compart-ments (n= 39)	US	35/37 (94.6)	1/2 (50.0)	35/36 (97.2)	1/3 (33.3)	36/39 (92.3)
	CT	29/37 (78.4)	2/2 (100)	29/29 (100)	2/10 (20.0)	31/39 (79.5)

	US/CT	36/37	1/2	36/37	1/2	37/39
		(97.3)	(50.0)	(97.3)	(50.0)	(94.9)
Primary tumor ≤ 1cm						
Central	US	22/45	115/141	22/48	115/138	137/186
compart-		(48.9)	(81.6)	(45.8)	(83.3)	(73.7)
ments	CT	27/45	117/141	27/51	117/135	144/186
(n=186)		(60.0)	(83.0)	(52.9)	(86.7)	(77.4)
	US/CT	30/45	104/141	30/67	104/119	134/186
		(66.7)	(73.8)	(44.8)	(87.4)	(72.0)
Lateral	US	11/12	0/2	11/13	0/1	11/14
compart-		(91.7)	(0.0)	(84.6)	(0.0)	(78.6)
ments	CT	11/12	2/2	11/11	2/3	13/14
(n= 14)		(91.7)	(100.0)	(100.0)	(66.7)	(92.8)
	US/CT	11/12	0/2	11/13	0/1	11/14
		(91.7)	(0.0)	(84.6)	(0.0)	(78.6)

≤ 1 cm: tumor 10 mm or less in maximum diameter; > 1 cm: tumor more than 10mm in maximum diameter; US: ultrasound; CT: computed tomography; PPV: positive predictive value; lateral compartment: right or left levels Ⅱ to V; central compartment: right and left level Ⅵ; US/CT: combined results of US and CT. All neck compartments, central and lateral compartments were surgically dissected.

Table 6. Statistical Analysis for the Difference between Sensitivities and Specificities of US, CT, and US/CT in the Evaluation of Lymph Node Metastasis

Analysis	Comparison	Sensitivity	Specificity	Accuracy
All lesions				
Central	US vs. CT	0.040*	0.979	0.201
Compartments	US vs. US/CT	0.002*	0.032**	0.719
(n=299)	CT vs. US/CT	0.306	0.043**	0.357
Lateral	US vs. CT	0.064	0.143	0.403
Compartments	US vs. US/CT	1.0	1.0	0.750
(n=53)	CT vs. US/CT	0.025*	0.143	0.251
Primary tumor > 1 cm				
Central	US vs. CT	0.070	0.494	0.322
Compartments	US vs. US/CT	0.009*	0.124	0.322
(n=113)	CT vs. US/CT	0.425	0.390	1.0
Lateral	US vs. CT	0.041**	1.0	0.103
Compartments	US vs. US/CT	1.0	1.0	1.0
(n=39)	CT vs. US/CT	0.028*	1.0	0.042*
Primary tumor ≤ 1 cm				
Central	US vs. CT	0.289	0.755	0.398
Compartments	US vs. US/CT	0.087	0.115	0.726
(n=186)	CT vs. US/CT	0.511	0.060	0.232
Lateral	US vs. CT	1.0	0.333	0.595
Compartments	US vs. US/CT	1.0	1.0	1.0
(n=14)	CT vs. US/CT	1.0	0.333	0.595

P-values were tested by Chi-Square and †Fischer's Exact test with a significance level of 0.05. *P*-values*: the latter imaging modality is significantly better than the former, *P*-values**: the former imaging modality is significantly better than the latter.

Figure 4. A 28-year-old woman with PTC in the right lobe of the thyroid gland. An axial CT image shows a malignant mass with extrathyroidal extension (arrow) and a small lymph node with contrast enhancement (arrowhead) at right level Ⅲ. However, US detected no lymph node metastases in either lateral compartment. This nodal metastasis was confirmed by surgery.

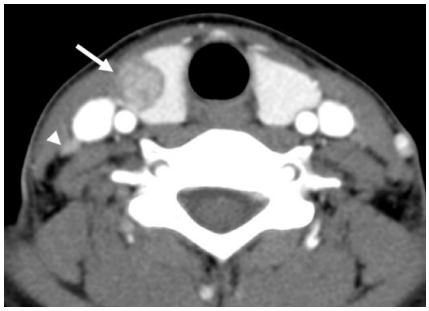
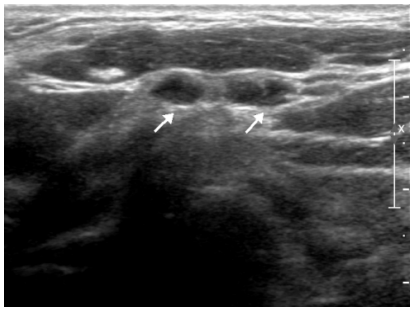
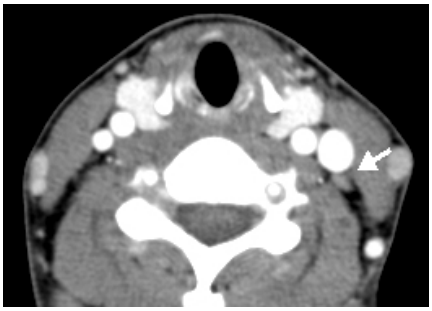


Figure 5. Lymph node metastasis in a 33-year-old woman with PTC. US image (A) shows small lymph nodes with internal cystic change at left level Ⅲ (arrows). However, on the CT image (B), the small lymph node at left level Ⅲ (arrow) does not appear suspicious. The preoperative N stage was therefore determined as N1b with US, and as N0 with CT. The T stage was finally confirmed as N1b by surgery.

A.  B. 

For PTC larger than 1 cm, both US/CT and US showed significantly higher sensitivities than CT alone in lateral compartments (p=0.028, 0.041), but sensitivity did not differ between US/CT and US alone. For the PTMC, we found no significant differences in sensitivity between US, CT, and US/CT in either central or lateral compartments.

IV. DISCUSSION

PTC has a good prognosis with a low incidence of distant metastasis, but cervical lymph node metastases may occur in 30% to 80% of patients[17-19]. Although lymph node metastases of PTC have little effect on overall survival[20], their presence increases the risk of local tumor recurrence[21,22], and repetitive recurrence may be even more life-threatening due to dedifferentiation[9]. To successfully manage PTC by surgery, accurate preoperative determination of lymph node metastasis is therefore important[3,4,9,23]. In addition to lymph node metastasis, it is also important to predict the size of tumors and extrathyroidal extensions preoperatively because tumor size and extrathyroidal extension are regarded as independent risk factors for tumor recurrence[9,24,25]. For small PTCs limited to one lobe and without extrathyroidal invasion, a thyroid lobectomy can be performed, rather than total thyroidectomy[26]. Therefore, accurate preoperative T and N staging is clinically relevant in patients with PTC[3,4,9,23].

High-resolution US can detect and characterize thyroid nodules, identify calcifications, and assess nodal vascularity[10]. US can also be used to guide fine-needle aspiration of thyroid nodules and suspicious cervical lymph nodes[5]. However, US depends on the skill of operators and is limited in ability

to detect of lymph nodes in the retropharyngeal space, mediastinum, low level Ⅵ, or of tumor extension to the adjacent structures[27]. On the other hand, CT may play a critical role in the detection of metastatic lymph nodes in occult areas that are poorly assessed by US and evaluation of tumor extension into adjacent structures including the esophagus and trachea[28]. In this study, preoperative evaluation of extrathyroidal tumor extension was significantly more accurate with US than with CT.

We investigated the performances of US, CT, and US/CT in the detection of lymph node metastasis based on compartments, rather than individual levels, because each involved compartment is usually dissected as a single unit. At our hospital, we routinely dissect the central compartment at surgery for guidance in both therapy and prevention of recurrence in PTC. But we dissected the lateral compartments only when necessary.

Recent studies showed low sensitivities (51-62%) and high specificities (79-98%) for US in preoperative detection of lymph node metastasis from PTC in level-by-level analysis[10,29,30], but few studies have tested the accuracy of CT for this purpose[28,30]. Ahn et al.[30] reported significantly higher sensitivity with CT than US in preoperative evaluations of nodal metastases in the whole neck and lateral levels. In the present study, we found a much higher sensitivity with US in the lateral compartments (93.9%) than in previous

reports (65.0%-76.2%)[6,30]. We think these differences may be related to differences in diagnostic criteria, the small number of lateral node metastases, or differences in analytical methods for lymph node metastasis (e.g., by level vs. by compartment).

We also found significantly higher sensitivity with CT in the detection of central compartment lymph node changes. However, this finding may have less clinical significance because surgeons in many institutions dissect central neck nodes routinely[31-34]. However, the lateral compartment is usually dissected only in patients with suspected lateral lymph node metastasis or having a high risk of lymph node recurrence[9,35]. Therefore, preoperative detection of lateral compartment metastasis strongly influences the type of therapeutic dissection for this compartment. Our data showed a higher sensitivity for US and US/CT than for CT in the preoperative detection of lateral compartment metastasis, and significantly higher for PTC larger than 1 cm; but the sensitivities of US and US/CT in the lateral compartment did not differ significantly. In PTMC with small numbers of lateral compartment metastases (n=12), US/CT showed no advantage to US alone.

Recently Sugitani et al. reported patients with PTC demonstrating large primary tumors (≥4 cm) or distant metastasis were at high-risk for recurrence in the lateral compartments, in spite of negative lateral compartments on

preoperative US. Therefore, they recommended prophylactic lateral lymph node dissection to reduce nodal recurrence for these patients[36]. In this study, we focused on preoperative staging of PTC using imaging modalities. Because of this, further study using long-term follow-up data might be needed to evaluate the optimal extent of surgery.

The present study has several limitations. First, CT is superior to US in advanced cases with large tumor sizes or invasion to adjacent structures[27,28]; but our study included only one patient (in 299) with tracheal invasion (T4a), and only 33 with tumor diameters larger than 2 cm. This bias would tend to lower the apparent accuracy of CT in preoperative evaluation of PTC. Second, we analyzed lymph node metastasis by compartment, and could not directly correlate radiological findings of suspected lymph node metastases with the pathological evaluation. Our findings should therefore be confirmed using other analytical methods (e.g., node-by-node or level-by-level). Third, lateral neck nodes were dissected only in patients with suspect nodes, and this study included only 4 lateral compartments with negative results out of 53 lateral compartments dissected by surgery. This increases the uncertainty in our determination of specificity for detection of lateral compartment metastasis. We believe that this limitation is inevitable, however, because routine prophylactic lateral compartment dissection is not recommended for PTC

patients[9,35]. To overcome this limitation requires a large study group.

V. CONCLUSION

In conclusion, high-resolution US can provide an accurate preoperative evaluation of extrathyroidal tumor extension and lateral lymph node (levels Ⅱ to Ⅴ) metastasis. CT showed higher sensitivity than US alone in detecting central lymph node metastasis for overall lesions. For PTMC, however, there was no significant difference in diagnostic accuracy between US, CT, and US/CT.

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Abstract (In Korean)

유두상 갑상선암의 수술전 병기결정에 있어서 초음파와 CT의 비교

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최지수

본 연구는 유두상 갑상선암의 수술전 병기결정에 사용되고 있는 초음파와 CT(computed tomography;전산화 단층촬영)의 진단적 정확도를 비교하고, 초음파만 단독으로 시행했을 경우에 비해서 CT가 부가적인 진단적 가치를 제공할 수 있는지에 대해 알아보고자 하였다. 세침흡인 검사상 유두상 갑상선암으로 진단받고 세브란스 병원에서 갑상선 수술을 받았던 299명의 환자를 대상으로 하였다. 종양과 림프절 전이에 대한 병기결정에 있어서 초음파와 CT 각각의 진단적 정확도를 평가하고, 동시에 초음파와 CT를 모두 이용하여 진단하였을 때의 정확도를 같이 평가하였다. 통계 분석에서는 전체 환자를 종양의 크기에 따라 두 소집단(1cm 이하 (유두상 미세갑상선암)/ 1cm 초과)으로 나누어 추가분석을 시행하였다. 전체 환자와 두 소집단 모두에서 갑상선외 침습(extrathyroidal tumor extension)과 양측성 갑상선암을 진단하는 데 있어서 초음파가 CT보다 더 정확하였다 ($p<0.05$). 전체 환자에서 중앙부 림프절 전이를 예측하는 데 있어서는 CT가 초음파보다 높은 민감도를 보였다. 두 소집단 분석에서 초음파와 CT를 모두 이용하였을

경우가 초음파만 이용한 경우보다 중앙부 림프절 전이 예측에 대한 민감도가 더 높았으나, 유두상 미세갑상선암 집단에서는 통계적으로 유의하지는 않았다. 측부 림프절 전이를 예측하는 데에 있어서, CT만을 이용하였을 때보다 초음파만 이용한 경우와 초음파와 CT를 모두 이용한 경우에서 민감도가 더 유의하게 높았다. 그러나 초음파만 이용한 경우와 초음파와 CT를 모두 이용한 경우간의 차이는 없었다. 이상의 결과로 수술전 초음파는 갑상선외 침습과 측부림프절 전이를 정확하게 예측할 수 있음을 알 수 있었다. 중앙부 림프절 전이를 예측하는 데 있어서는 CT가 초음파보다 높은 민감도를 보였다. 그러나 유두상 미세갑상선암 소집단에서는 초음파 혹은 CT만을 이용한 경우, 초음파와 CT를 모두 이용한 경우간에 진단적 정확도에 유의한 차이가 없었다.

핵심되는 말: 초음파, CT (전산화 단층촬영), 유두상 갑상선암, 수술전