Ultrasound in Med. & Biol., Vol. 41, No. 5, pp. 1294–1300, 2015

0301-5629/$ - see front matter

http://dx.doi.org/10.1016/j.ultrasmedbio.2015.01.003

● *Original Contribution*

PRE-OPERATIVE ULTRASOUND DIAGNOSIS OF NODAL METASTASIS IN PAPILLARY THYROID CARCINOMA PATIENTS ACCORDING TO NODAL COMPARTMENT

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(*Received* 18 *September* 2014; *revised* 7 *January* 2015; *in final form* 16 *January* 2015)

Abstract—The aim of this study was to assess the accuracy of ultrasound (US) and individual US features in the diagnosis of nodal metastasis in patients with papillary thyroid carcinoma (PTC) with respect to nodal compartment. US diagnoses and individual US features of nodal metastases with respect to nodal compartment were investigated in 184 consecutive PTC patients who underwent pre-operative US. Histopathologic results were used as a reference standard. One hundred thirty-six of 368 (37.0%) central compartments contained one or more metastatic nodes, whereas 44 of 48 (91.7%) lateral compartments had one or more metastatic nodes. The malignancy rates of suspicious US diagnoses in the central and lateral compartments were 66.3% (53/80) and 93.3% (42/45), respectively. The central and lateral compartments differed significantly in nodal composition, echogenicity, calcification, shape, hilar echogenicity and vascularity. The accuracy of US in the diagnosis of nodal metastases from PTC was lower in the central compartment than in the lateral compartment. (E-mail: dwultra@lycos.co.kr or dwultra@naver.com)

Key Words: **Papillary thyroid carcinoma, Lymph node, Metastasis, Ultrasound, Compartment, Neck.**

INTRODUCTION

Papillary thyroid carcinoma (PTC) is the most common type of differentiated thyroid carcinoma in children and adults, constituting up to 80%–90% of all thyroid cancers (Loevner 2011). PTC is well known as a lymphotropic type of cancer and, thus, has a high tendency to metastasize to regional lymph nodes (LNs) (Sippel 2013). Nodal metastasis is present in approximately 5%–10% of patients with PTC (Grubbs and Evans 2007; Ito et al. 2003; Kim et al. 2008; Sippel 2013; Stulak et al. 2006) and is considered to be a risk factor for local tumor recurrence and cancer-specific mortality (Ito et al. 2005; Mazzaferri and Kloos, 2001; Sellers et al. 1992). Furthermore, imaging-based pre-operative diagnosis of nodal metastasis in PTC patients can alter the type and extent of surgery (Kim et al. 2008; Stulak et al. 2006). Thus, accurate pre-operative nodal staging is important for determining prognosis, as well as tailoring surgical treatment in thyroid cancer patients.

Ultrasound (US) has been established as the first-choice diagnostic method for thyroid lesions, whereas computed tomography (CT) has been restricted to pre-operative tumor–node–metastasis staging (Ahn et al. 2008; Kim et al. 2008; Rumboldt et al. 2006). Although CT and magnetic resonance imaging can be used for tumor and nodal staging in patients with head and neck cancer (Som et al. 1994), CT has a low resolution for soft tissues, radiation hazards and high cost (Liu et al. 2014). Although CT has been used for pre-operative nodal staging in PTC patients, a combination of US and CT may be superior to US alone for the detection of

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Conflicts of Interest: No conflicts of interest or other financial interests exist.

metastatic LNs in these patients (Kim et al. 2008). In contrast, other investigators have reported that US is more accurate than CT in evaluating lateral node metastases in PTC patients (Choi et al. 2009). Although many studies have addressed the diagnostic value of US in pre-operative diagnosis of central node metastases from PTC, the results have varied (Ahn et al. 2008; Hwang and Orloff 2011; Ito et al. 2003, 2005). Several investigators have reported that the sensitivity of US for central node metastasis detection is only 10.9% in PTC patients, compared with 39% for lateral node metastasis detection (Ito et al. 2003, 2005). In another study, the sensitivity and specificity of US in detecting central node metastases were 55% and 69%, respectively (Ahn et al. 2008). However, to the best of our knowledge, no previous studies have investigated the influence of nodal compartment on the diagnostic accuracy of US in PTC patients using specific US features. Therefore, this study was aimed at assessing the diagnostic accuracy of US and individual US features in detecting nodal metastases from PTC with respect to nodal compartment.

METHODS

Study population

The study was approved by the institutional review board (IRB 14-0133) of Busan Paik Hospital before subject selection, and informed consent was waived because of the retrospective nature of the study. One hundred eighty-four consecutive patients (150 women and 34 men; mean age ± standard deviation, 49.1 ± 11.2 y; age range, 22–75 y) who received pre-operative neck US and subsequent total thyroidectomy for the treatment of PTC between June and December 2011 were included in this study. Surgeons were aware of the pre-operative US diagnoses and performed resection of all visible and palpable LNs based on pre-operative clinical and US findings.

US diagnosis

Neck US was performed using a high-resolution US instrument (iU 22, Philips Medical Systems, Bothell, WA, USA) equipped with a 5- to 12-MHz linear probe. All US examinations were performed by a single radiologist with 12 y of experience in neck US. To evaluate nodal vascularity patterns, a low-pulse-repetition frequency (700 Hz), velocity scale (4.0 or 5.0 cm/s) and gain setting (between 72 and 79) were routinely used during color Doppler US. Color Doppler gain was controlled to eliminate random color noise in normal perinodal fatty tissue.

Pre-operative US of both the central and lateral compartments of the neck was performed. Each LN was classified according to nodal composition (solid, partially cystic [with intranodal cystic component(s)] or pure cyst); echogenicity (iso-echoic, decreased or increased echogenicity compared with that of the adjacent strap muscle or an echogenic island [presence of an echogenic solid component within the LN]); calcification (no calcification, microcalcification, macrocalcification or mixed calcification [microcalcification + macrocalcification]); margin (smooth, ill-defined, lobulated or irregular); shape (bean, ovoid, round [anteroposterior diameter to transverse diameter ratio >0.8 and anteroposterior diameter to longitudinal diameter ratio ≤ 1], taller-than-wide [anteroposterior diameter to transverse diameter ratio or anteroposterior diameter to longitudinal diameter ratio >1] or irregular); hilar echogenicity (preserved, thinning or loss of the echogenic hilum); and nodal vascularity (hilar [predominant vascular signal in the hilar portion], scant [few vascular spots], peripheral [higher vascular signal in the peripheral portion than in the central portion], central [higher vascular signal in the non-hilar central portion than in the peripheral portion regardless of the presence of an echogenic hilum] or mixed [similar vascular signal in the peripheral and central portions]).

In all cases, LNs were immediately diagnosed under real-time US examination. Metastatic LNs were defined as those with at least one of the following five malignant features on pre-operative US: intranodal cystic component, diffusely increased echogenicity, microcalcification, irregular margin or taller-than-wide shape (Kim et al. 2013; Kim et al. 2008). The following US features were not considered diagnostic criteria for metastatic LNs: intranodal echogenic island, macrocalcification and loss of echogenic hilum (Kim et al. 2013). US features of benign LNs included iso-echogenicity, bean shape, preserved or thinning echogenic hilum and hilar vascularity (Kim et al. 2013; Kim et al. 2008). Nodal size was not a determinant of nodal malignancy.

Nodal classification in the neck

Nodal levels were divided into central and lateral compartments to assess the adequacy of nodal staging by US in determining surgical method and the histopathologic "per patient" standard. The central compartment is commonly referred to as level VI of the neck and is located between the medial margins of the bilateral carotid arteries from the inferior border of the innominate (brachiocephalic) artery or the sternal notch to the superior boundary of the hyoid bone. The central compartment includes the pretracheal, paratracheal, prelaryngeal/Delphian and perithyroidal LNs, including nodes along the recurrent laryngeal nerves. The lateral compartment of the neck is located from the medial margin of the carotid artery to the medial margin of the trapezius muscle and includes level I, II, III, IV and V LNs. The criteria to determine the sonographically