Clinical features and outcomes of thyroid hyalinizing trabecular tumors: An 11-year experience at a tertiary referral hospital

HYE RIN LIM[1*], HYE-BIN JANG[1*], KYUNG-HWA LEE[2], JI SHIN LEE[2] and TAE MI YOON[1]

[1]Department of Otolaryngology-Head and Neck Surgery, Chonnam National University Medical School and Hwasun Hospital, Hwasun, Jeonnam 58128, Republic of Korea; [2]Department of Pathology, Chonnam National University Medical School and Hwasun Hospital, Hwasun, Jeonnam 58128, Republic of Korea

Received September 20, 2024; Accepted March 14, 2025

DOI: 10.3892/etm.2025.12886

Abstract. Hyalinizing trabecular tumors (HTTs) of the thyroid are rare neoplasms that generally exhibit benign behavior, lacking capsular or vascular invasion. Despite this, HTTs often present histopathological features that closely resemble those of papillary thyroid carcinoma (PTC), posing an important diagnostic challenge and leading to the frequent misinterpretation of fine needle aspiration biopsy (FNAB) results as PTC. The present study aimed to investigate the clinical characteristics and outcomes of HTTs observed over 11 years at a tertiary referral hospital [Chonnam National University Hwasun Hospital (Hwasun, South Korea)]. A retrospective analysis was conducted on 11 patients with pathologically confirmed HTT, evaluated between March 2011 and December 2021, following their final histological examinations after surgery. Of the 9,169 patients who underwent thyroid surgery during this period, 11 patients (0.12%) were histologically diagnosed with HTT. FNAB was performed in 10 patients, but HTT was included in the differential diagnosis in only 1 patient, while 6 patients were suspected as PTC or unspecific carcinoma. The average tumor size measured by preoperative ultrasonography (US) was 1.7±1.1 cm (range, 0.3-3.9 cm). The majority of tumors appeared hypoechoic with well-defined margins, and no US features indicative of malignancy were observed. Surgical management included thyroid lobectomy in 6 patients and total thyroidectomy in 5 patients. Over a mean follow-up period of 38 months, no recurrences or metastases were observed. In summary, these findings highlight the limited diagnostic utility of FNAB or US in the preoperative identification of HTTs. In cases where preoperative US findings are benign and FNAB results suggest PTC, HTT should be considered in the differential diagnosis to avoid overtreatment.

Correspondence to: Dr Tae Mi Yoon, Department of Otolaryngology-Head and Neck Surgery, Chonnam National University Medical School and Hwasun Hospital, 322 Seoyang-Ro, Hwasun, Jeonnam 58128, Republic of Korea
E-mail: yoontm@chonnam.ac.kr

*Contributed equally

Key words: thyroid hyalinizing trabecular tumor, papillary thyroid carcinoma, fine needle aspiration biopsy, histopathological evaluation

Introduction

Hyalinizing trabecular tumors (HTTs) of the thyroid, which were first described by Carney *et al* (1) in 1987, represent a rare subtype of thyroid neoplasm that continues to present both clinical and pathological diagnostic challenges. These tumors are defined by their characteristic hyalinized stroma and trabecular growth pattern (2). Clinically, HTTs that usually present as asymptomatic, well circumscribed and solitary masses exhibit a benign course, with no evidence of capsular or vascular invasion (3). Even in rare cases where malignant features, such as focal invasion, are observed, the prognosis remains favorable, with no reports of recurrence or metastasis following surgical resection (1,4). Therefore, HTTs have traditionally been classified and managed as benign entities. Despite their benign nature, HTTs are frequently misdiagnosed as papillary thyroid carcinomas (PTCs) due to overlapping nuclear features, such as nuclear grooves, and intranuclear pseudoinclusions observed under light microscopy (5,6). These shared features can lead to confusion in the preoperative setting, particularly because PTC is a much more common malignant tumor of the thyroid with distinct clinical and histological implications (5,6). Furthermore, the amyloid-like appearance of the hyalinized stroma in HTTs may mimic the amyloid deposits characteristic of medullary thyroid carcinoma (MTC), leading to diagnostic confusion (5). Preoperative differentiation of HTTs from these malignancies is particularly challenging using fine needle aspiration biopsy (FNAB), often resulting in unnecessary overtreatment such as total thyroidectomy or lymph node dissection that is inappropriate for benign tumors. The potential harm of overtreatment of these cases emphasizes the need for a more nuanced understanding of HTTs and highlights the importance of refining diagnostic tools to differentiate them from other thyroid tumors. The present study aimed to address these diagnostic challenges by analyzing the clinical characteristics of HTTs over an 11-year period at a tertiary referral center. The findings of the present study may aid in the establishment of more accurate differential diagnostic

criteria and guide the development of appropriate management strategies for similar cases.

Materials and methods

Patients. A retrospective analysis was conducted on the medical record data for 11 patients with pathologically confirmed HTTs based on their final histological examinations following thyroid surgeries at Chonnam National University Hwasun Hospital (CNUHH; Hwasun, South Korea), which functions as a tertiary referral hospital and regional national cancer institution. The patients underwent thyroid surgery between March 2011 and December 2021. Patients diagnosed with HTT were included, while patients without appropriate follow-up were excluded. The patients' characteristics, including the age and sex, are described in the results section and Table I. Clinical data were collected and analyzed retrospectively. The clinical information obtained included the patients' sex, age, past medical history, type of surgery (lobectomy or total thyroidectomy), tumor size, FNAB results, ultrasonography (US) features, final histopathological findings and follow-up duration. The present study was approved by the Institutional Review Board of CNUHH (approval no. CNUHH-2024-175).

FNAB process. All FNAB procedures were performed under US guidance using a 25-gauge needle. The aspirated cellular material was immediately smeared onto glass slides, fixed with 95% ethanol for 15 min, and subsequently stained in hematoxylin for 1-3 min and then stained in Papanicolaou (PAP) for 1-3 min, at room temperature (7). Cytological interpretations (8,9) were carried out by experienced pathologists. The Korean Thyroid Association recommends FNAB for thyroid nodules >10 mm (10); however, FNAB is often performed on smaller nodules based on patient requests or clinical judgment. For this reason, FNAB was performed on some HTT cases with 3- or 5-mm nodules.

Immunohistochemical (IHC) analysis. Resected tumor samples were fixed at room temperature in 10% formalin for 3 days, embedded in paraffin and cut in 3-μm tissue sections. An automated immunostainer (BOND-MAX DC2002; Leica Microsystems, Inc.) was used for staining. The sections were stained with hematoxylin for 5-15 min and eosin for 1-3 min, at room temperature, and anti-human Ki-67 (MIB-1 clone; cat. no. 790-4286; Roche Diagnostics), calcitonin (cat. no. A0576; Dako; Agilent Technologies, Inc.), high molecular weight cytokeratin (HMCK; cat. no. M0630; Dako; Agilent Technologies, Inc.), CD56 (cat. no. M7304; Dako; Agilent Technologies, Inc.), paired box 8 (PAX8; cat. no 363M-15; Cell Marque; MilliporeSigma), thyroid transcription factor 1 (TTF-1, cat. no. M3575; Dako; Agilent Technologies, Inc.), BRAF V600E (cat. no. 760-5095; Roche Diagnostics) or CD31 (cat. no. M0823; Dako; Agilent Technologies, Inc.) antibodies. The specimens were reviewed by pathologists to confirm the diagnosis of HTT under a light microscope (11,12).

Results

Patients characteristics. The demographic and clinical characteristics of the 11 patients diagnosed with HTTs are summarized in Table I. Between March 2011 and December 2021, a total of 9,169 patients underwent thyroid surgery at CNUHH. Among these, 11 patients (0.12%) were histologically confirmed to have HTTs. Individual patient characteristics are detailed in Table II. Of the 11 patients, 1 (9.1%) was male and 10 (90.9%) were female, with a mean age of 54.9±11.2 years (range, 39-69 years). A total of 10 patients presented with an incidentally detected thyroid mass identified by US during routine medical checkups, while 1 patient presented with a lateral neck mass as the primary symptom.

Table I. Clinical characteristics of patients with hyalinizing trabecular tumors.

Characteristic	Value
Sex	
Male	1
Female	10
Age, years	54.9±11.2
Underlying disease	
Hypertension	4
Diabetes	1
Asthma	1
Other malignancy or tumor	3
None	5
Tumor long diameter, cm	1.7±1.1
Fine needle aspiration biopsy result	
Hurtle cell neoplasm	1
Suspicious for papillary thyroid carcinoma	5
Suspicious for medullary thyroid carcinoma	1
Benign nodule (adenomatous goiter, follicular nodule)	3
Atypia of undetermined significance	2
Suspicious for carcinoma, unspecified	1
Hyalinizing trabecular adenoma	1
Feature of ultrasonography	
Well-defined	8
Ill-defined	3
Hypoechoic	10
Isoechoic	1
Heterogenous	10
Homogenous	1

Data are presented as the number of patients or the mean ± standard deviation.

US findings. The mean tumor size, as measured by the longest dimension on US, was 1.7±1.1 cm (range, 0.3-3.9 cm). Although no consistent US features were observed, most tumors (7 cases) appeared as hypoechoic lesions with well-defined margins (6 cases, heterogenous, Fig. 1A; 1 case, homogenous, Fig. 1B). Three tumors appeared as ill-defined, hypoechoic heterogenous lesions (Fig. 1C), and one tumor appeared as a well-defined, heterogenous isoechoic lesion (Fig. 1D).

Table II. Individual characteristics of patients with hyalinizing trabecular tumors.

Sex	Age, years	Underlying disease	Operation type	Size, cm	FNA biopsy result	Feature of ultrasonography	Biopsy result	IHC staining
F	69	None	Rt. lobectomy	3.1	Hurtle cell neoplasm	Well-defined, heterogenous and hypoechoic	HTT and oncocytoma	MIB-1(-)
F	41	HTN	TT with CLND	0.5	Some irregular clusters of follicular cells and numerous histocytes, suggestive of cystic change of adenomatous goiter	Well-defined, heterogeneous and isoechoic	HTT accompanied by PTC in the contralateral lobe	MIB-1(+)
F	62	HTN	TT	0.6	No aspiration for HTT (FNA for other nodules: Suspicious for PTC)	Well-defined, heterogenous and hypoechoic	HTC accompanied by PTC in the bilateral lobe	MIB-1(+)
F	64	HTN	TT	2.2	Suspicious for PTC and MTC	Well-defined, heterogenous and hypoechoic	Hyalinizing trabecular adenoma, nodular hyperplasia with papillary epithelial growth and Hashimoto's thyroiditis	MIB-1(+); calcitonin(-)
F	55	None	TT with CLND	2.4	Suspicious for PTC	Well-defined, heterogenous and hypoechoic	HTT	MIB-1(+); HMCK (focal+); CD56(+)
F	50	None	TT with CLND	1.4	Benign, suggestive for adenomatous goiter	Well-defined, heterogeneous and hypoechoic	HTT accompanied by PTC in ipsilateral lobe	MIB-1(+); HMCK(-)
M	52	Thymoma	Rt. lobectomy	3.9	Atypia of undetermined significance	Ill-defined, heterogeneous and hypoechoic	HTT, nodular hyperplasia with papillary epithelial growth and Hashimoto's thyroiditis	None performed
F	39	HTN, DM and breast cancer	Rt. lobectomy	1.0	Suspicious for PTC and hyalinizing trabecular adenoma	Well-defined, homogeneous and hypoechoic	Hyalinizing trabecular adenoma	MIB-1(+)
F	69	None	Lt. lobectomy with CLND	1.2	Atypia of undetermined significance (first aspiration); suspicious for PTC (second aspiration)	Ill-defined, heterogeneous and hypoechoic	HTT	MIB-1(+)
F	41	None	Rt. lobectomy with CLND;	2.2	Suspicious for carcinoma or metastatic carcinoma	Well-defined, heterogeneous and hypoechoic	HTT	MIB-1(+); PAX8(+);

Table II. Continued.

Sex	Age, years	Underlying disease	Operation type	Size, cm	FNA biopsy result	Feature of ultrasonography	Biopsy result	IHC staining
			Rt. MRND type III					TTF-1(+); BRAF(-); calcitonin(-); CD31(-)
F	62	Asthma and leukemia	Lt. lobectomy	0.3	Benign follicular nodule (first aspiration); suspicious for PTC (second aspiration)	Ill-defined, heterogeneous and hypoechoic	HTT accompanied by PTC in ipsilateral lobe	MIB-1(+)

F, female; M, male; HTN, hypertension; DM, diabetes mellitus; Rt., right; Lt., left; TT, total thyroidectomy; CLND, central lymph node dissection; MRND, modified radical neck dissection; HMCK, high molecular weight cytokeratin; IHC, immunohistochemical; FNA, fine needle aspiration; HTT, hyalinizing trabecular tumor; PAX8, paired box 8; TTF-1, thyroid transcription factor 1; PTC, papillary thyroid carcinoma; MTC, medullary thyroid carcinoma.

FNAB findings. FNAB was performed on all 11 patients as part of the preoperative evaluation. A total of 10 out of the 11 patients underwent FNAB for a mass identified as HTT in the permanent biopsy after surgery. Out of 10 patients, 8 patients underwent FNAB once, while 2 patients underwent FNAB twice. However, in 1 patient, FNAB targeted another nodule that suggested PTC, rather than HTT. Of the 10 FNAB-targeted HTT masses, cytological findings suggested the inclusion of HTT in the differential diagnosis in only 1 patient. Nevertheless, even in this instance, the findings could not reliably differentiate between PTC and HTT. Additionally, in total 6 patients including 1 patient in whom HTT and PTC could not be differentiated, the FNAB findings indicated suspicious malignancy, including PTC or unspecified carcinoma. Detailed FNAB findings for the 11 cases are presented in Table II.

Surgery, histopathological findings and prognosis. Surgical interventions included thyroid lobectomies in 6 patients and total thyroidectomies in 5 patients. Among the 5 patients who underwent total thyroidectomies, 3 patients exhibited both HTTs and PTCs in the same, contralateral or bilateral lobes upon final histological examination. Similarly, 1 patient who underwent a lobectomy was diagnosed with both a PTC and an HTT within the same lobe. One patient underwent total thyroidectomy due to FNAB findings that were inconclusive between MTC and PTC. Another patient underwent total thyroidectomy upon personal request. Notably, intraoperative frozen-section biopsies were not performed in any of the 11 cases based on the surgeon's judgement during the surgery. In all cases, the final histopathological evaluation revealed tumors that were clearly demarcated from the surrounding non-neoplastic thyroid tissue (Fig. 2A). Under high magnification, tumor cells exhibited trabecular and organoid arrangements, abundant eosinophilic cytoplasm with hyaline material, nuclear grooves and intranuclear inclusions (Fig. 2B), which supported the definitive diagnosis of HTT. IHC analysis revealed membranous positivity for Ki-67/MIB-1 clone in 9 cases (Fig. 2C). This membranous staining of MIB-1 is the characteristic pathological finding of HTT. The IHC staining results used for differential diagnosis are summarized in Table II. To exclude PTC from the differential diagnosis of HTT, the immunohistochemical markers HMCK, CD56 and BRAF were utilized (11-13). Calcitonin staining was employed to distinguish HTT from MTC (11-13), while CD31 was used to assess vascular invasion (14). Thyroid follicular origin was confirmed using PAX8 and TTF-1 (11,12). The present study involved patients over an 11-year-long period, and as a result the IHC slides have faded, making them unsuitable for publication. Therefore, a MIB-1 IHC image from a representative patient was presented. Postoperative follow-up was conducted for a mean duration of 38 months (range, 3-132 months). All patients remained free of recurrence or metastasis, and no major postoperative complications were reported.

Discussion

HTTs are described in the literature as rare neoplasms originating from follicular cells, occurring in middle-aged women between 40 and 70 years and typically exhibiting benign

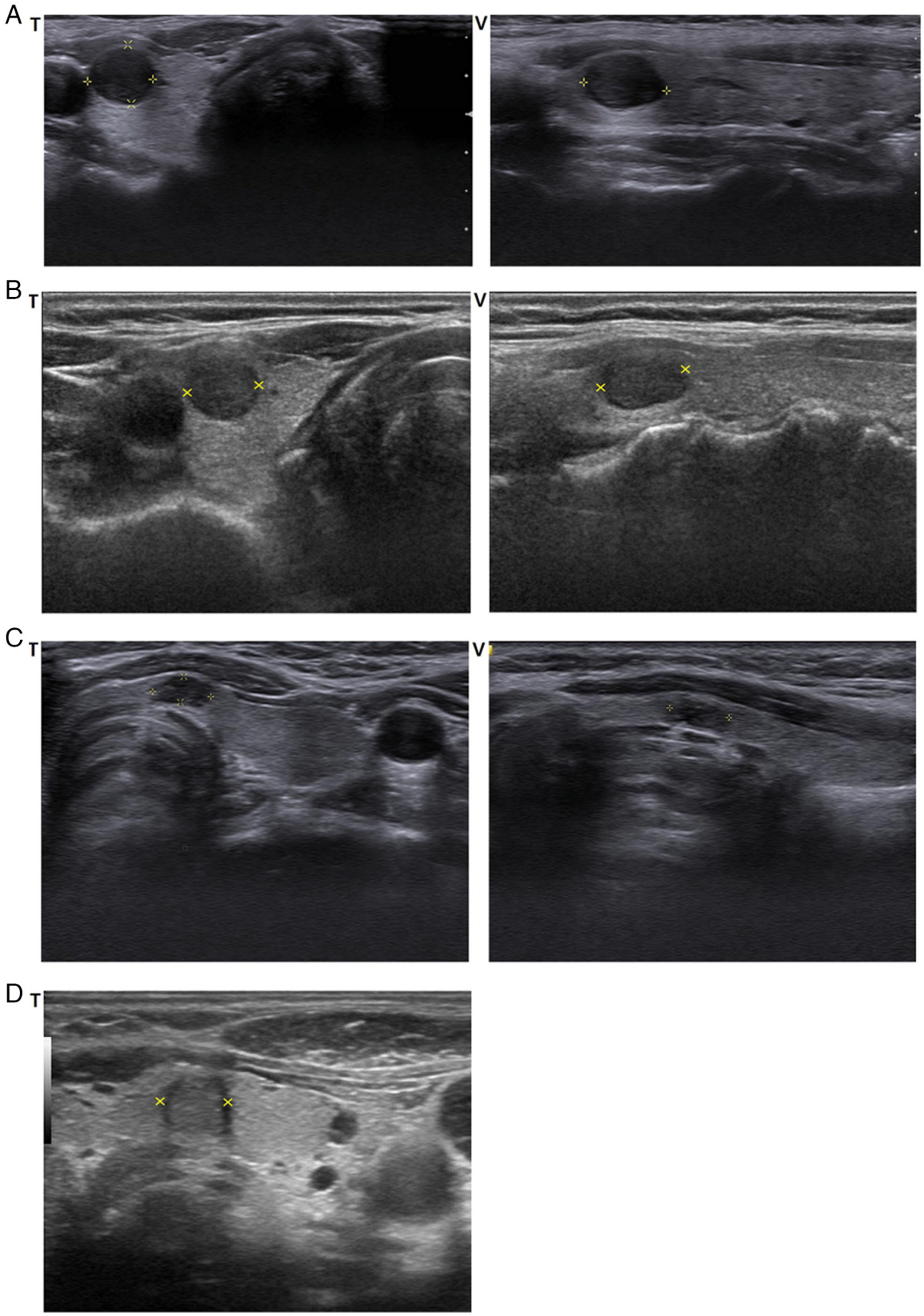

Figure 1. Ultrasonography findings of hyalinizing trabecular tumors. (A) Most tumors (6 cases) appeared as heterogenous hypoechoic lesions with well-defined margins. (B) One tumor appeared as a homogenous hypoechoic lesion with well-defined margins. (C) Three tumors appeared as ill-defined, hypoechoic heterogenous lesions. (D) One tumor appeared as well-defined, heterogenous isoechoic lesion. The yellow crosses indicate the edges of the lesions. T, transverse view; V, vertical view.

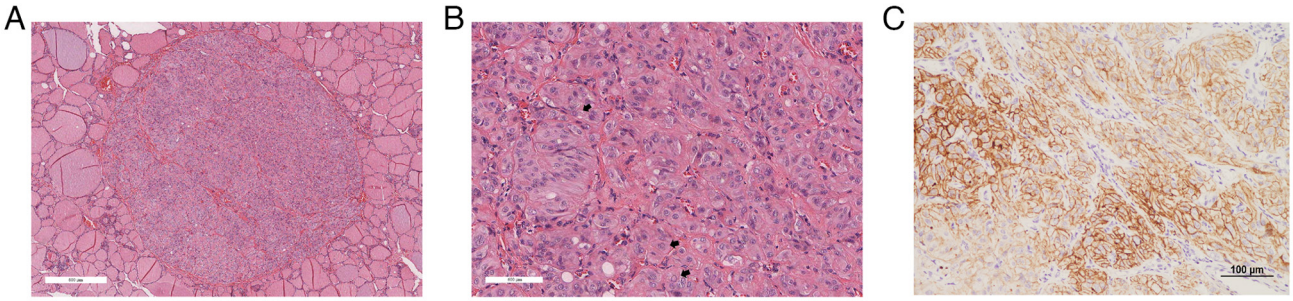

Figure 2. Pathological features of thyroid hyalinizing trabecular tumors. (A) The tumor is well delineated from uninvolved thyroid tissue (hematoxylin and eosin staining; magnification, x40). (B) Tumor cells are arranged in trabecular and organoid architectures, with abundant eosinophilic cytoplasm containing hyaline material. Nuclear grooves and intranuclear inclusions (arrows) are observed (hematoxylin and eosin staining; magnification, x200). (C) Ki-67 immunostaining using the MIB-1 monoclonal antibody shows strong membranous staining (magnification, x200).

behavior (15-18). The etiology of HTTs remains unclear; however, associations with chronic lymphocytic thyroiditis, Hashimoto's thyroiditis, multinodular goiter, a history of neck radiation exposure and PTC have been documented (17-19). Notably, instances of HTTs coexisting with micropapillary thyroid carcinoma have also been reported (20). In the present study, 4 out of 11 cases (36.4%) were accompanied by PTC in either the contralateral or ipsilateral lobe, and 2 patients presented with concurrent Hashimoto's thyroiditis. These findings are consistent with the aforementioned previous reports highlighting conditions associated with HTTs.

HTTs were first described by Carney *et al* (1) in 1987, who characterized their clinical and pathological features as either solitary lesions or components of multinodular presentations. These tumors are generally small, measuring ≤2 cm, with gross pathology revealing well-defined margins and capsular formation (1,2). Microscopically, HTTs are distinguished by the trabecular arrangement of polygonal, oval or spindle-shaped tumor cells set within a hyalinizing stroma (21-23). Certain trabeculae may appear curved, forming ribbon- or festoon-like patterns (24).

Although cases of HTTs with capsular invasion, vascular invasion, lymph node metastases and even lung metastases have been reported (25,26), Carney *et al* (2) noted that of 19 patients with HTTs, 18 exhibited benign clinical courses without malignancies, even in tumors with features suggestive of malignancy, and no recurrences or metastases were observed during long-term follow-up. Similarly, in the present study, none of the 11 patients demonstrated evidence of recurrence or metastasis during the follow-up period.

On preoperative FNAB, HTTs may present nuclear grooves, intranuclear inclusions and occasionally psammoma bodies, which can result in a misdiagnosis of PTC (19,21,22). Additionally, the hyalinizing stroma can mimic amyloid deposits, leading to potential diagnostic confusion with MTC (27). In certain cases, the tumor cells form glandular patterns, posing challenges in distinguishing HTTs from paragangliomas (23). Misdiagnoses due to cytological similarities with PTC or MTC have been documented, underscoring the necessity for meticulous histopathological evaluation and further research to refine diagnostic approaches for HTTs (20,22,24,27). The clues for an accurate diagnosis of HTTs include the absence of papillary structures or fibrovascular stalks and the presence of elongated nuclei in association with hyaline stroma (11,12). Although certain studies have explored the use of preoperative US, FNAB and frozen-section histopathology to identify HTTs, no definitive clinical diagnostic criteria for preoperative differentiation have been established (28,29). In the present study, only 1 patient was suspected to represent HTT based on preoperative FNAB, while diagnostic challenges were evident in 6 patients suspected as having PTC or unspecific carcinoma.

The final diagnosis of HTTs can only be confirmed through pathological examination. In cases where distinguishing tumor types based on histological features is challenging, IHC analysis plays a pivotal role. Unlike PTCs, which typically demonstrate minimal reactivity to the MIB-1 antibody, HTTs exhibit strong positive reactivity to MIB-1, localized along the tumor cell membranes. In the present study, 9 cases displayed MIB-1 positivity. Additionally, while PTCs exhibit strong positive IHC staining for galectin-3, HMCK and cytokeratin 19, HTTs generally show negative or weakly positive staining for these markers (30-32). IHC staining also distinguishes HTTs from MTCs, as HTTs are positive for thyroglobulin and negative for neuroendocrine markers, such as calcitonin, synaptophysin and chromogranin, whereas MTCs exhibit the opposite staining pattern (27).

Molecular analyses have further identified *RET/PTC* rearrangements in both PTCs and HTTs; however, *BRAF* and *N-Ras* mutations commonly observed in PTCs are absent in HTTs (13,33,34). Notably, Nikiforova *et al* (35) reported a high prevalence of *GLIS* rearrangements, particularly *PAX8-GLIS3*, in HTTs but not in PTCs. Among indeterminate FNAB results, *PAX8-GLIS3* was detected in 0.1% of cases, and all 5 surgically confirmed cases were diagnosed as HTT, underscoring the utility of molecular testing using preoperative FNAB material (35). The incidence of HTT in the present study (~0.12%) aligns with the aforementioned reported rate, further highlighting the rarity of this entity. The lack of genetic testing is the main limitation of the present study. The current study was conducted over an 11-year-long period, which includes a notable time before the introduction of molecular testing for HTT. However, further research on the clinical impact of molecular testing, including *GLIS* rearrangements, on the diagnosis and treatment of HTT will be an important topic for future studies.

Despite these diagnostic advances, the utility of US and FNAB in reliably diagnosing HTTs preoperatively remains limited (28,29). Nevertheless, when preoperative US findings suggest the occurrence of benign tumors, but FNAB results

raise suspicion for malignancy, particularly PTC, the differential diagnosis should include HTT. Particularly for FNAB results suspicious for PTC, the absence of *BRAF* mutations may heighten the suspicion for HTT. However, as demonstrated by the low incidence of HTT in the present study (only 11 cases among 9,169 thyroidectomy patients), its rarity poses an important diagnostic challenge for clinicians and pathologists (11). Limited exposure of clinicians to HTTs and their cytological features may further contribute to the difficulty in achieving a preoperative diagnosis. It is imperative for clinicians and pathologists to recognize the key clinical, cytological and molecular characteristics of HTT, including the use of additional tests, such as *GLIS* rearrangements, to improve diagnostic accuracy (36).

However, in cases of thyroid nodules, >30% of patients fall into the non-diagnostic, indeterminate and follicular neoplasm categories under the Bethesda System (8,9), where treatment decisions are unclear. However, cytological IHC and molecular testing are not performed for all cytologically difficult cases. IHC and molecular testing on preoperative cytological material could be helpful in the differential diagnosis, but this is only possible when clinicians or pathologists suspect HTT through conventional clinical aspects, including basic FNAB and US findings. As is often the case with rare entities, the main obstacle to diagnostic accuracy seems to be simply considering the diagnosis of HTT. Therefore, the present study is likely to help clinicians in suspecting HTT and considering further diagnostic tests.

Early clinical suspicion for HTT is crucial, as it may prevent unnecessary surgical procedures, such as total thyroidectomy. Compared with total thyroidectomy, thyroid lobectomy offers several advantages, including preservation of thyroid function, reduced dependence on lifelong thyroid hormone replacement therapy and avoidance of complications, such as recurrent laryngeal nerve injury and hypocalcemia (37). The type of thyroid surgery significantly impacts patient quality of life; therefore, when HTT is suspected preoperatively, a diagnostic lobectomy is preferable to total thyroidectomy to optimize patient outcomes through reduced surgical intervention (38).

In conclusion, while the diagnostic utility of US and FNAB for HTTs remains limited, their findings, in conjunction with molecular and IHC analyses, can aid in the identification of HTT preoperatively. In cases where preoperative US findings appear benign but discrepancies with FNAB results raise suspicion for PTC, HTT should be considered in the differential diagnosis. When HTT is clinically suspected, diagnostic lobectomy is recommended over total thyroidectomy to minimize surgical burden and preserve quality of life.

Acknowledgements

Not applicable.

Funding

The present study was supported by Chonnam National University (grant nos. 2022-2747 and 2023-0898).

Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

HRL, HBJ and TMY analyzed the data and drafted the manuscript. JSL and KHL analyzed pathological data. TMY participated in the design of the study. HRL, HBJ and TMY contributed to the interpretation of the data. All authors read and approved the final version of the manuscript. HBJ and TMY confirm the authenticity of all the raw data.

Ethics approval and consent to participate

The present study was approved by the Institutional Review Board of Chonnam National University Hwasun Hospital (Hwasun, South Korea; approval no. CNUHH-2024-175). Patients provided written informed consent for the use of resected tissue specimens in research.

Patient consent for publication

Patients provided written informed consent for the publication of research results on their resected tissue specimens.

Competing interests

The authors declare that they have no competing interests.

References

1. Carney JA, Ryan J and Goellner JR: Hyalinizing trabecular adenoma of the thyroid gland. Am J Surg Pathol 11: 583-591, 1987.
2. Carney JA, Hirokawa M, Lloyd RV, Papotti M and Sebo TJ: Hyalinizing trabecular tumors of the thyroid gland are almost all benign. Am J Surg Pathol 32: 1877-1889, 2008.
3. Gupta S, Modi S, Gupta V and Marwah N: Hyalinizing trabecular tumor of the thyroid gland. J Cytol 27: 63-65, 2010.
4. Katoh R, Jasani B and Williams ED: Hyalinizing trabecular adenoma of the thyroid. A report of three cases with immunohistochemical and ultrastructural studies. Histopathology 15: 211-224, 1989.
5. Evenson A, Mowschenson P, Wang H, Connolly J, Mendrinos S, Parangi S and Hasselgren PO: Hyalinizing trabecular adenoma-an uncommon thyroid tumor frequently misdiagnosed as papillary or medullary thyroid carcinoma. Am J Surg 193: 707-712, 2007.
6. McCluggage WG and Sloan JM: Hyalinizing trabecular carcinoma of thyroid gland. Histopathology 28: 357-362, 1996.
7. Bongiovanni M, Cibas ES and Faquin WC: The role of thyroid fine needle aspiration cytology and the Bethesda system for reporting thyroid cytopathology. Diagn Histopathol 17: 95-105, 2011.
8. Baloch ZW, LiVolsi VA, Asa SL, Rosai J, Merino MJ, Randolph G, Vielh P, DeMay RM, Sidawy MK and Frable WJ: Diagnostic terminology and morphologic criteria for cytologic diagnosis of thyroid lesions: A synopsis of the national cancer institute thyroid fine-needle aspiration state of the science conference. Diagn Cytopathol 36: 425-437, 2008.
9. Crippa S, Mazzucchelli L, Cibas ES and Ali SZ: The Bethesda system for reporting thyroid fine-needle aspiration specimens. Am J Clin Pathol 134: 343-345, 2010.
10. Yi KH, Lee EK, Kang HC, Kim SW, Kim IJ, Park SY, Nam KH, Park JW, Bae SK, Baek SK, *et al*: 2016 Revised Korean thyroid association management guidelines for patients with thyroid nodules and thyroid cancer. Int J Thyroidol 9: 59-126, 2016.
11. Bishop JA and Ali SZ: Hyalinizing trabecular adenoma of the thyroid gland. Diagn Cytopathol 39: 306-310, 2011.
12. Rossi ED, Papotti M, Faquin W, Larocca LM and Pantanowiz L: The diagnosis of hyalinizing trabecular tumor: A difficult and controversial thyroid entity. Head Neck Pathol 14: 778-784, 2020.
13. Podany P and Gilani SM: Hyalinizing trabecular tumor: Cytologic, histologic and molecular features and diagnostic considerations. Ann Diagn Pathol 54: 151803, 2021.

14. Lin X, Zhu B, Liu Y and Silverman JF: Follicular thyroid carcinoma invades venous rather than lymphatic vessels. Diagn Pathol 5:8, 2010.
15. DeLellis RA, Lloyd RV, Heitz PU and Eng C: Pathology and genetics of tumours of endocrine organs: WHO Classification of Tumours. Vol 8. 3rd edition. PathologyOutlines.com, Inc., Michigan, p300, 2004.
16. Ergün S, Akıncı O, Öztürk T and Karataş A: Hyalinizing trabecular tumor of the thyroid gland. Turk J Surg 34: 149-151, 2018.
17. Nosé V, Volante M and Papotti M: Hyalinizing trabecular tumor of the thyroid: An update. Endocr Pathol 19: 1-8, 2008.
18. Thompson LDR: Hyalinizing trabecular adenoma of the thyroid gland. Ear Nose Throat J 90: 416-417, 2011.
19. Seo JH, Kim JP and Woo SH: A case of hyalinizing trabecular adenoma of the thyroid gland. Int J Thyroidol 10: 46-49, 2017.
20. Jong HS, Kim EJ and Kim SW: A case of thyroid haylinizing trabecular tumor mistaken for papillary carcinoma in aspiration cytology. Korean J Head Neck Oncol 34: 33-36, 2018.
21. Howard BE, Gnagi SH, Ocal IT and Hinni M: Hyalinizing trabecular tumor masquerading as papillary thyroid carcinoma on fine-needle aspiration. ORL J Otorhinolaryngol Relat Spec 75: 309-313, 2013.
22. Lee HK, Kim HS, Hur MH, Kang SS, Lee JH and Lee SK: Hyalinizing trabecular adenoma of thyroid gland. J Korean Surg Soc 62: 87-90, 2002.
23. Park KS, Kim SW, Min HS, Han WS, Noh DY, Park SH, Youn YK, Oh SK and Choe KJ: Hyalinizing trabecular adenoma of thyroid. J Korean Surg Soc 65: 572-575, 2003.
24. Yim H, Shim C and Soh EY: Hyalinizing trabecular adenoma of the thyroid: A case report. Korean J Pathol 32: 226-230, 1998.
25. Sambade C, Franssila K, Cameselle-Teijeiro J, Nesland J and Sobrinho-Simões M: Hyalinizing trabecular adenoma: A misnomer for a peculiar tumor of the thyroid gland. Endocr Pathol 2: 83-91, 1991.
26. Gowrishankar S, Pai SA and Carney JA: Hyalinizing trabecular carcinoma of the thyroid gland. Histopathology 52: 529-531, 2008.
27. Han JJ, Lee YJ, Choi MC, Kwon M, Chon S and Lee J: A case of hyalinizing trabecular tumor of the thyroid gland misdiagnosed as medullary carinoma at cytologic examination. J Korean Endocr Soc 23: 327-331, 2008.
28. Kuma S, Hirokawa M, Miyauchi A, Kakudo K and Katayama S: Cytologic features of hyalinizing trabecular adenoma of the thyroid. Acta Cytol 47: 399-404, 2003.
29. Sung SY, Shen HY, Hsieh CB, Duh QY, Su TF, Chan DC and Shih ML: Hyalinizing trabecular tumor of thyroid: Does frozen section prevent unnecessarily aggressive operation? Six new cases and a literature review. J Chin Med Assoc 77: 573-577, 2014.
30. Hirokawa M, Carney JA and Ohtsuki Y: Hyalinizing trabecular adenoma and papillary carcinoma of the thyroid gland express different cytokeratin patterns. Am J Surg Pathol 24: 877-881, 2000.
31. Hirokawa M and Carney JA: Cell membrane and cytoplasmic staining for MIB-1 in hyalinizing trabecular adenoma of the thyroid gland. Am J Surg Pathol 24: 575-578, 2000.
32. Gaffney RL, Carney JA, Sebo TJ, Erickson LA, Volante M, Papotti M and Lloyd RV: Galectin-3 expression in hyalinizing trabecular tumors of the thyroid gland. Am J Surg Pathol 27: 494-498, 2003.
33. Salvatore G, Chiappetta G, Nikiforov YE, Decaussin-Petrucci M, Fusco A, Carney JA and Santoro M: Molecular profile of hyalinizing trabecular tumours of the thyroid: High prevalence of RET/PTC rearrangements and absence of B-raf and N-ras point mutations. Eur J Cancer 41: 816-821, 2005.
34. Dell'Aquila M, Gravina C, Cocomazzi A, Capodimonti S, Musarra T, Sfregola S, Fiorentino V, Revelli L, Martini M, Fadda G, *et al*: A large series of hyalinizing trabecular tumors: Cytomorphology and ancillary techniques on fine needle aspiration. Cancer Cytopathol 127: 390-398, 2019.
35. Nikiforova MN, Nikitski AV, Panebianco F, Kaya C, Yip L, Williams M, Chiosea SI, Seethala RR, Roy S, Condello V, *et al*: GLIS rearrangement is a genomic hallmark of hyalinizing trabecula tumor of the thyroid gland. Thyroid 29: 161-173, 2019.
36. Nikiforova MN, Nikiforov YE and Ohori NP: GLIS rearrangements in thyroid nodules: A key to preoperative diagnosis of hyalinizing trabecular tumor. Cancer Cytopathol 127: 560-566, 2019.
37. Farkas EA, King TA, Bolton JS and Fuhrman GM: A comparison of total thyroidectomy and lobectomy in the treatment of dominant thyroid nodules. Am Surg 68: 678-683, 2002.
38. Kim BC, Pak SJ, Cho JW, Kim WW, Lee YM, Sung TY, Baek JH and Chung KW: Clinical characteristics of the hyalinizing trabecular tumor. J Endocr Surg 22: 116-122, 2022.