Recommendation and Guideline

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Standardized Imaging and Reporting for Thyroid Ultrasound: Korean Society of Thyroid Radiology Consensus Statement and Recommendation

Min Kyoung Lee[1], Dong Gyu Na[2], Leehi Joo[3], Ji Ye Lee[4], Eun Ju Ha[5], Ji-Hoon Kim[4], So Lyung Jung[1], Jung Hwan Baek[6]

[1]Department of Radiology, Yeoido St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea; [2]Department of Radiology, Gangneung Asan Hospital, Ulsan University College of Medicine, Gangneung, Korea; [3]Department of Radiology, Korea University Guro Hospital, Seoul, Korea; [4]Department of Radiology, Seoul National University Hospital, Seoul National University College of Medicine, Seoul, Korea; [5]Department of Radiology, Ajou University Hospital, Ajou University School of Medicine, Suwon, Korea; [6]Department of Radiology and Research Institute of Radiology, University of Ulsan College of Medicine, Asan Medical Center, Seoul, Korea

Ultrasonography (US) is a primary imaging modality for diagnosing nodular thyroid disease and has an essential role in identifying the most appropriate management strategy for patients with nodular thyroid disease. Standardized imaging techniques and reporting formats for thyroid US are necessary. For this purpose, the Korean Society of Thyroid Radiology (KSThR) organized a task force in June 2021 and developed recommendations for standardized imaging technique and reporting format, based on the 2021 KSThR consensus statement and recommendations for US-based diagnosis and management of thyroid nodules. The goal was to achieve an expert consensus applicable to clinical practice.

Keywords: *Thyroid; Ultrasonography; Recommendation*

INTRODUCTION

Nodular thyroid disease is very common. The thyroid nodules are detected by palpation and ultrasonography (US) in 2%–21% and 19%–68% of cases, respectively [1-6]. The incidence of thyroid cancer has increased in many countries and concerns have been raised about overdiagnosis and overtreatment of thyroid cancer [7-9]. Meanwhile, recent trend of decreasing incidence of small indolent thyroid cancers have been reported in the South Korea [10] and the thyroid cancer incidence–based mortality increased over the recent years in the United States [11].

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Corresponding author: Dong Gyu Na, MD, PhD, Department of Radiology, Gangneung Asan Hospital, Ulsan University College of Medicine, 38 Bangdong-gil, Sacheon-myeon, Gangneung 25440, Korea.
• E-mail: nndgna@gmail.com

US is the primary imaging modality for diagnosing nodular thyroid disease [12], and has an essential role in identifying the most appropriate management strategy for patients with nodular thyroid disease. Clinically, US is used for thyroid nodule detection and risk stratification, as well as for preoperative evaluation of primary tumor and cervical lymph nodes in patients with thyroid cancers, and postoperative surveillance. The roles of a recently introduced US-based risk stratification system (RSS) and the Thyroid Imaging Reporting and Data System (TIRADS) have expanded from simply estimating the malignancy risk for a nodule to US-based management of patients with thyroid nodules, which involves assessing the presence of aggressive thyroid cancer, identifying patients eligible for biopsy, and managing thyroid nodules before and after biopsy [13-15].

The Korean Society of Thyroid Radiology (KSThR) published premiere recommendation for US evaluation of thyroid nodules in 2011 [16], and proposed the Korean TIRADS (K-TIRADS) for risk stratification of thyroid nodules in the revised recommendations of 2016 [17]. Based on recent advanced studies on the diagnosis and management of thyroid nodules, as well as validation studies on RSSs and TIRADS, the KSThR revised the K-TIRADS in 2021 [13]. In the revised 2021 K-TIRADS, some US lexicons were simplified and clarified to reduce unnecessary biopsies for benign nodules, while maintaining appropriate sensitivity for the detection of malignant tumors in small (1–2 cm) thyroid nodules. Although most institutions in Korea perform thyroid US examinations based on the KSThR recommendations, standardized imaging techniques and reporting formats are not currently available, despite their importance for establishing best-practice protocols for thyroid patients in Korea.

Therefore, the clinical practice guideline committee of the KSThR organized a taskforce in June 2021 and began development of standardized imaging techniques and reporting formats for thyroid US based on the KSThR recommendations [13] and expert consensus. These recommendations are intended to provide useful and straightforward guidance for clinical practice, and to encourage the utilization of a standardized reporting format for thyroid US.

Thyroid Ultrasound Imaging Technique

Table 1 summarizes the imaging technique for thyroid US, including the equipment, patient position, scan range, and technical considerations.

Equipment

High-resolution US equipment and a high-frequency linear transducer (10–15 MHz) are required to evaluate the thyroid gland and neck, due to the superficial location of the thyroid gland and neck lymph nodes within the neck space [18,19]. Additional scanning with a lower-frequency transducer can improve diagnostic accuracy in patients with a large amount of fat or muscle and/or a large neck circumference. This approach is also useful for evaluating thyroid gland conditions, such as severe goiter and upper mediastinum abnormalities [19]. Color Doppler US is required to assess diffuse thyroid disease, the vascularity of the thyroid nodules, the presence of abnormal vascularity in cervical lymph nodes, and perithyroidal vascular structures before planning a biopsy or interventional procedures [13,20].

Scanning Technique

To optimize thyroid US examinations, patients should lie in the supine position with the neck hyperextended. During thyroid US examination, an appropriate scan range is important for comprehensive evaluation of the entire thyroid gland and cervical lymph nodes (Table 1). The locations of pathologic cervical lymph nodes should be recorded as levels according to the imaging-based nodal classification system [21]. Central neck lymph nodes can be classified as pretracheal, paratracheal, and prelaryngeal [22].

Scanning of the thyroid gland and central neck should include the transverse plane, through which the transducer

Table 1. Details of Thyroid Ultrasound Imaging Technique

Equipment	High-frequency linear transducer (10–15 MHz)
Position of patients	Supine, hyperextension of neck
Scan range	Thyroid and central neck lymph nodes (levels 1A and 6) Lateral neck lymph nodes (levels 1B, 2, 3, 4, and 5)
Technical considerations	
Neck compression with US probe	
Advantages	Reduces ultrasound beam attenuation Aids detection and characterization of deeply located thyroid nodules in patients with a thick neck Dynamic evaluation of suspected extrathyroidal lesions
Disadvantages	May change the original orientation (shape) of the thyroid nodule May decrease the vascularity of the thyroid nodule and superficial cervical lymph node
Contralateral head rotation	
Advantages	Aids evaluation of lymph nodes in the tracheoesophageal groove (level 6) and thyroid nodules close to the tracheal wall May minimize artifactual change of nodule echogenicity (through a “sonic window” of the sternocleidomastoid muscle)
Disadvantages	May change the original orientation (shape) of the thyroid nodules and original position of some cervical lymph nodes

US = ultrasonography

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sweeps from the submental region to the sternal notch. Transverse scanning of the midline central neck includes the pyramidal lobe, isthmus, and prelaryngeal/pretracheal central neck lymph nodes (levels 1A and 6); this method can also be used to detect ectopic (accessory) thyroid tissue, thyroglossal duct cysts, and nodules arising from ectopic thyroid tissue. Transverse scanning of the paramedian central neck should include the bilateral thyroid lobes (upper, middle, and lower portions), bilateral paratracheal lymph nodes, and parathyroid lesions in the central neck. Longitudinal scans should include the right and left thyroid lobes; longitudinal scans of the isthmus may also be necessary to differentiate nodules in the isthmus or pyramidal lobes from perithyroidal lymph nodes. Transverse scanning of the lateral neck should include the lateral compartment lymph nodes (levels 1B, 2, 3, 4, and 5), with the transducer sweeping from the submandibular region to the supraclavicular fossa and posterior neck compartment. The acquired static US images of the thyroid should include transverse images of the superior, middle, and inferior portions of the right and left thyroid lobes; a transverse image of the isthmus; longitudinal images of both thyroid lobes; and transverse images of the infrathyroidal central neck and lateral neck.

There are several technical considerations when performing US examinations of thyroid and cervical lymph nodes. In general, the US probe should be gently placed on the anterior neck surface during US scanning of the thyroid gland and neck. Neck compression with the US probe can help detect and characterize deeply located thyroid nodules in patients with a thick neck by reducing US beam attenuation [23]. However, compression with the US probe may change the original orientation (shape) of a thyroid nodule and decrease its vascularity, as well as that of superficial cervical lymph nodes. Head rotation to the contralateral side is helpful for evaluating level 6 lymph nodes located in the tracheoesophageal groove and thyroid nodules close to the tracheal wall. Head rotation can also facilitate assessment of nodule echogenicity by minimizing artifactual changes (through a "sonic window" of the sternocleidomastoid muscle). However, head rotation may change the orientation (shape) of thyroid nodules and position of cervical lymph nodes relative to landmarks of major vessels and the sternocleidomastoid muscle. Therefore, the head of the patient should be held straight, without rotation, to obtain the natural orientation of the thyroid nodules [24] and allow imaging of lymph nodes in an anatomically neutral position.

Standardized Reporting Format for Thyroid Ultrasound

The standardized reporting format of thyroid US is based on the 2021 KSThR recommendations and expert consensus on imaging-based management of thyroid nodules [13], as summarized in Table 2. Thyroid US reports should include clinical information, general features of the thyroid gland, thyroid nodule, cervical lymph node, extrathyroidal lesion and additional findings (if present), the biopsy procedure (if performed), conclusion (summary report), and recommendations for the management of patients (if necessary).

Clinical Information and General Features of the Thyroid

Clinical information of interest includes the reasons for US examination (i.e., palpable anterior neck mass, thyroid incidentaloma, etc.) and past history of thyroid US examination, thyroid surgery, biopsy, etc. Data on the general features of the thyroid include size, parenchymal echogenicity, echotexture, parenchymal vascularity, and the presence of diffuse thyroid disease or multinodular goiter.

The thyroid size is indicated by the anteroposterior, transverse, and longitudinal diameters of each lobe, and the isthmus thickness, while the thyroid volume is estimated by the ellipsoid formula. In adults, the anteroposterior and transverse dimensions of the lateral lobes are approximately 1.3–2.0 cm, the length of the lateral lobes is 4–6 cm, and the thickness of the isthmus is < 0.3–0.5 cm [25-28]. However, thyroid size varies according to age, weight, and gender [29]. Considering the normal variation in thyroid size, it can be visually estimated and categorized as normal, increased (goiter), or decreased (hypoplasia or atrophy).

The echogenicity of thyroid parenchyma is defined according to the reference standard of presumed normal thyroid echogenicity (typical homogeneous hyperechogenicity). The echogenicity of a normal parotid gland may be used as an alternative reference standard for normal thyroid echogenicity; however, the normal submandibular gland is not suitable as a reference standard when assessing the normal echogenicity of thyroid parenchyma [30]. The echotexture of thyroid parenchyma is categorized based on the uniformity of the thyroid echogenicity. The echotexture is reported as homogeneous if the thyroid parenchyma shows a uniform appearance, and

Table 2. Standardized Reporting Format for Thyroid Ultrasound

1. Clinical information	
Indication for examination	Palpable anterior neck mass, thyroid incidentaloma, etc.
Clinical history	History of previous US examination, thyroid surgery, biopsy, etc.
2. General features	
Thyroid size (volume)	Three diameters of each lobe (volume), normal/increase/decrease
Diffuse thyroid disease	Absence/presence
Parenchymal echogenicity; echotexture	Normal/decreased echogenicity (hypoechogenicity), homogeneous/heterogeneous
Parenchymal vascularity	Normal/increased/decreased
Multinodular goiter	Absence/presence
3. Thyroid nodules	
Location	Right lobe/left lobe (upper, mid, lower)/isthmus (right, left)
Size change	Three diameters/volume or maximum diameter, stable/increased/decreased/new
Composition	Solid/predominantly solid/predominantly cystic/cystic, spongiform
Echogenicity	Markedly hypoechoic/mildly hypoechoic/isoechoic/hyperechoic
Orientation	Parallel/nonparallel (taller-than-wide)
Margin	Smooth/irregular/ill-defined
Echogenic foci	Punctate echogenic foci/macrocalcification/rim calcification/intracystic echogenic foci with comet tail artifact, entirely calcified nodule
Other features	Extensive parenchymal punctate echogenic foci without discrete nodules, diffusely infiltrative lesions suspicious for infiltrative malignancy
Vascularity	None/peripheral/mild intranodular/marked intranodular vascularity
Extrathyroidal extension	None/minor/gross
4. Cervical lymph nodes	
Location*	Neck level (1A, 1B/2A, 2B/3/4/5A, 5B/6)
Size change	Long or short diameter, increased/stable/decreased/new
US category	Suspicious/indeterminate/probably benign
5. Extrathyroidal lesion	Parathyroid lesion, developmental cyst, esophageal diverticulum, coexisting non-thyroid origin nodal disease, etc.
6. Biopsy procedure (if performed)	Target thyroid nodule or lymph node, type of biopsy, number of biopsy samplings, immediate complications
7. Conclusion	
Diffuse thyroid disease	Absent/present
Thyroid nodule	Location, size, K-TIRADS category
Cervical lymph node	Absence/presence of suspicious or enlarged indeterminate lymph node, neck level
8. Recommendation	Biopsy, US follow-up, surgery, etc.

*The supraclavicular lymph nodes are included in level 5B [13]. K-TIRADS = Korean Thyroid Imaging Reporting and Data System, US = ultrasonography

as heterogeneous if it shows a non-uniform appearance due to mixed or coarse echogenicity, or diffuse tiny hypoechoic nodular lesions. Diffuse thyroid disease can be defined by the presence of decreased parenchymal echogenicity, a coarse or nodular parenchymal echotexture, marginal nodularity, or increased or decreased parenchymal vascularity [31,32]. The vascularity of the thyroid gland is categorized as normal, increased, and decreased pattern [31].

Thyroid Nodules

Reports of thyroid nodules should include the location, size, composition, echogenicity, orientation, margin, presence of echogenic foci, nodule vascularity, and presence of extrathyroidal extension (ETE). In cases of multiple thyroid nodules, their US characteristics can be selectively reported according to the malignancy risk and nodule size.

The nodule location should be described as right or left lobe (upper, mid, or lower), isthmus, and if necessary, lateral, medial, anterior, or posterior. Nodules > 1 cm should be reported as three-dimensional measurements of a nodule (anteroposterior, transverse, and longitudinal diameters), with or without the estimated volume. For small

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nodules (≤ 1 cm), the nodule size can be reported as the maximum diameter. For three-dimensional measurement of a nodule, the maximum diameter should be measured on the transverse image, along with the maximum diameter perpendicular to the previous measurement on the same transverse image, and the maximum longitudinal diameter on a sagittal image [33]. In cases with multiple thyroid nodules, the three diameters (with or without the estimated volume) can be measured for one or two larger nodules; the maximum diameter can be measured for the other nodules. During follow-up, the change in nodule size and/or volume should be reported to determine the appropriate management strategy [13]. Significant nodule growth is defined as an increase in diameter of > 20% and an increase in size of > 2 mm in at least two dimensions, or a change in volume of > 50% [15]. For active surveillance of biopsy-proven or suspicious low-risk thyroid microcarcinomas, the maximum diameter (with or without the tumor volume) must be reported for evaluation of the size change at the US follow-up. Tumor enlargement is generally defined as an increase of ≥ 3 mm on US during active surveillance [34]. Tumor enlargement can also be defined as a 50% increase in tumor volume (by measuring the three dimensions) [35-37]; this is more sensitive for detecting tumor enlargement, but may have higher interobserver variability [38]. For thyroid nodules undergoing ablation therapy, the three diameters and volume of the target nodule should be reported before and after ablation therapy for evaluation of the nodule size change at follow-up.

The composition of a nodule is categorized according to the ratio between the cystic and solid portions, as follows: solid, no obvious cystic component; predominantly solid, cystic portion ≤ 50%; predominantly cystic, cystic portion > 50%; and cystic, no obvious solid component. Spongiform appearance of a nodule is defined as the aggregation of multiple nodular or linear microcystic components (> 50% of the solid component of the partially cystic nodule). An isoechoic or hyperechoic partially cystic nodule with a spongiform appearance can be regarded as benign (K-TIRADS 2). The echogenicity of a nodule is reported relative to the echogenicity of reference structures, including normal thyroid parenchyma and the anterior neck muscles, and can be classified into the following four categories: markedly hypoechoic, hypoechoic or similar echogenicity to the anterior neck muscle; mildly hypoechoic, hypoechoic relative to the normal thyroid parenchyma and hyperechoic relative to the anterior neck muscles; isoechoic, same echogenicity as the normal thyroid parenchyma; and hyperechoic, hyperechoic relative to the normal thyroid parenchyma [13]. If the echogenicity of a nodule is heterogeneous, the echogenicity is determined by the predominant echogenicity of the solid portion.

The orientation of a thyroid nodule is categorized according to its growth direction. A nonparallel orientation is defined as an anteroposterior diameter larger than the transverse diameter in the transverse image plane. The margin of a nodule is classified as smooth, ill-defined, or irregular (spiculated or microlobulated). Echogenic foci (calcification) is defined as hyperechoic foci within the solid portion of a nodule, categorized as punctuate echogenic foci (microcalcifications; echogenic foci ≤ 1 mm within the solid component), macrocalcifications (echogenic foci > 1 mm with posterior acoustic shadowing), complete or incomplete rim calcification (peripheral curvilinear hyperechoic line surrounding the nodule margin with or without posterior shadowing), or intracystic echogenic foci with a comet-tail artifact. Entirely calcified nodules are defined as calcified nodules with posterior acoustic shadowing, in which any soft tissue component is not obviously identified due to the dense posterior acoustic shadowing on US. Intracystic echogenic foci with comet-tail artifact is reliable and specific US feature for benign nodules (K-TIRADS 2) when the echogenic foci with comet-tail artifact are present within the cystic portion [39,40]. The composition, echogenicity, three suspicious US features (nonparallel orientation, irregular margin, and punctate echogenic foci), and US features specific for benignity (pure cyst, isoechoic spongiform appearance, and intracystic echogenic foci with comet tail artifact) are essential US features for risk stratification of nodules based on the 2021 K-TIRADS [13]. Entirely calcified nodules, extensive parenchymal punctate echogenic foci without discrete nodules (suspicious for a diffuse sclerosing variant of papillary thyroid carcinoma), and diffusely infiltrative lesions suspicious for infiltrative malignancy are classified as intermediate suspicion (K-TIRADS 4) nodules [13].

Nodule vascularity, as assessed by color Doppler US, and other ancillary US findings such as hypoechoic halo or elastographic features, do not necessarily need to be described in the US report, as they are not used for risk stratification of nodules in the K-TIRADS or other commonly used RSSs. However, the vascularity pattern of candidate nodules for chemical or thermal ablation therapy should be reported, given that nodule vascularity is important for

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determining the ablation therapy strategy and assessing outcomes at follow-up after ablation therapy [41,42].

The ETE is defined as direct extension of primary thyroid cancer into perithyroidal structures, and categorized as minor or gross ETE in the American Joint Committee on Cancer staging system (8th edition) [21]. The presence of minor or gross ETE should be reported according to the criteria proposed by the K-TIRADS [13] for US-based preoperative T staging of primary cancer [21]. However, histologically confirmed minor ETE was removed from the subclassification of the T category; only the gross ETE contributes to the T category subclassification. The presence or absence of ETE should be reported for biopsy-proven thyroid cancers, and may also be considered for nodules highly suspicious of thyroid cancer (K-TIRADS 5). The recommended US criteria for minor ETE are capsular disruption (anterolateral capsule) and protrusion (posterior capsule) [13]. The US criteria for gross ETE are invasion of the strap muscle, protrusion into the tracheoesophageal groove (invasion of the recurrent laryngeal nerve), and an obtuse angle between the tumor and trachea (invasion of the trachea) [13]. The presence of gross ETE, as indicated by obvious direct tumor extension into the larynx, trachea, esophagus, and perithyroidal vessels, should be reported regardless of the K-TIRADS category and nodule size, because those nodules require immediate biopsy to allow a decision to be made regarding surgical treatment. Suspicion of gross ETE into the laryngeal nerve and trachea should be reported in the case of K-TIRADS 5 nodules regardless of size, because those nodules are candidates for immediate biopsy to decide surgical treatment.

Cervical Lymph Node

According to the 2021 K-TIRADS, cervical lymph nodes are classified as suspicious, indeterminate, and probably benign based on their US features and estimated risk of metastasis from thyroid cancer [13]. Suspicious lymph nodes are those exhibiting cystic change, echogenic foci (punctate or large), cortical hyperechogenicity, or abnormal vascularity (73%–100% risk of malignancy) [43-48]. Lymph nodes that are probably benign are defined as lymph nodes that do not have any imaging features of suspicious lymph nodes and display typical imaging features of either an echogenic hilum or radiating hilar vascularity (< 3% risk of malignancy) [44,48]. The indeterminate lymph nodes are defined as lymph nodes without any imaging features of suspicious or probably benign lymph nodes and do not have echogenic hilum and hilar vascularity (approximate 20% malignancy risk) [44,48].

The location (neck level) and size (short or long diameter) of all suspicious and indeterminate lymph nodes with a short diameter > 5 mm should be reported for cervical lymph nodes; a detailed description of US features (shape, echogenic hilum, cortical echogenicity, echogenic foci, cystic change, and nodal vascularity) should also be provided.

Extrathyroidal Lesion and Additional Findings

Extrathyroidal lesions, including parathyroid lesions, developmental cysts, and esophageal diverticulum, can be detected incidentally during thyroid US. Extrathyroidal lesions may mimic metastatic lymph nodes or exophytic thyroid nodules. Concurrent malignant lymph nodes, including metastatic lymph nodes of non-thyroid origin and lymphoma, as well as benign nodal diseases such as tuberculous lymphadenitis, may also be detected and can coexist with metastatic lymph nodes from thyroid cancer. These additional findings may change the management of patients and should be described in the US report.

Biopsy Procedure

It is recommended that US-guided biopsy for thyroid and cervical lymph nodes be performed in accordance with the guidelines of the 2021 K-TIRADS [13]. When US-guided biopsy is performed for thyroid and cervical lymph nodes, detailed descriptions of the biopsy procedure, including the target nodule or lymph node, type of biopsy (fine-needle aspiration or core needle biopsy), number of biopsy samplings, and immediate complications after biopsy, should be provided in the US report.

Conclusion of the US Report

The conclusion of thyroid US reports the summary findings on general thyroid feature, thyroid nodule, cervical lymph node, extrathyroidal lesion, and biopsy procedure. The conclusion section should also briefly summarize regarding the absence or presence of diffuse thyroid disease; K-TIRADS category, location, and size of significant thyroid nodules; absence or presence of suspicious or enlarged indeterminate lymph nodes; and extrathyroidal lesions (if present). If biopsy was performed for the thyroid nodule or cervical lymph node, a brief description of the procedure and complications (if any) should be reported.

Recommendations for Patient Management

The 2021 K-TIRADS provides recommendations for the management of patients with thyroid nodules, including indications for biopsy of thyroid nodule and cervical lymph nodes, the follow-up strategy for nodules that do not meet the biopsy criteria, and management of thyroid nodules after biopsy [13]. The recommendation section of the standardized US report should include appropriate US-based recommendations, with consideration of individual clinical context of patients; this can help physicians develop optimized management strategies for patients with thyroid nodules [49].

Future Perspectives

The KSThR recommendations for standardized imaging and reporting for thyroid US were developed primarily for preoperative patients with nodular thyroid disease. We are in the process of creating a web-based program for convenient and informative thyroid US reporting for clinical practice. The standardized reporting format and web-based program are expected to promote efficient communication among physicians, thus aiding optimization of management strategies for patients with thyroid disease. In the future, the KSThR recommendations for US imaging techniques and reporting formats will be updated in accordance with academic advances in thyroid US and international consensus on US lexicon and US RSS.

Availability of Data and Material

Data sharing does not apply to this article as no datasets were generated or analyzed during the current study.

Conflicts of Interest

Dong Gyu Na, Ji-Hoon Kim, and Jung Hwan Baek, who is on the editorial board of the *Korean Journal of Radiology* was not involved in the editorial evaluation or decision to publish this article. All remaining authors have declared no conflicts of interest.

Author Contributions

Conceptualization: all authors. Data curation: all authors. Formal analysis: Min Kyoung Lee, Dong Gyu Na. Funding acquisition: Dong Gyu Na. Investigation: Min Kyoung Lee, Dong Gyu Na. Methodology: Min Kyoung Lee, Dong Gyu Na. Resource: Min Kyoung Lee, Dong Gyu Na, Ji Ye Lee. Supervision: Dong Gyu Na, Jung Hwan Baek. Writing—original draft: Min Kyoung Lee, Dong Gyu Na. Writing—review & editing: all authors.

ORCID iDs

Min Kyoung Lee
https://orcid.org/0000-0003-3172-3159
Dong Gyu Na
https://orcid.org/0000-0001-6422-1652
Leehi Joo
https://orcid.org/0000-0002-5527-0476
Ji Ye Lee
https://orcid.org/0000-0002-3929-6254
Eun Ju Ha
https://orcid.org/0000-0002-1234-2919
Ji-Hoon Kim
https://orcid.org/0000-0002-6349-6950
So Lyung Jung
https://orcid.org/0000-0002-3267-8399
Jung Hwan Baek
https://orcid.org/0000-0003-0480-4754

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