Cardiovasc Intervent Radiol (2021) 44:1651–1656
https://doi.org/10.1007/s00270-021-02838-w

TECHNICAL NOTE NON-VASCULAR INTERVENTIONS

Hydrodissection: A Novel Approach for Safe Core Needle Biopsy of Small High-Risk Subcapsular Thyroid Nodules

Hojat Ebrahiminik[1] · Hossein Chegeni[2] · Javad Jalili[3] · Rambod Salouti[2] · Hadi Rokni[4] · Afshin Mohammadi[5] · Ali Mosaddegh Khah[6] · Seyed Mohammad Tavangar[7] · Zahra Ebrahiminik[8]

Received: 26 October 2020 / Accepted: 31 March 2021 / Published online: 10 May 2021

Abstract
Purpose To evaluate the safety and effectiveness of core needle biopsy (CNB) under the assistance of hydrodissection (HDS).
Materials and Methods Of 2325 patients requiring biopsy of thyroid lesions, 21 high-risk patients with subcapsular nodules smaller than 10 mm were recruited into this study. All patients underwent HDS with 0.9% saline solution followed by ultrasound (US)-guided CNB with an 18-gauge semi-automated biopsy needle. The separation success rate (SSR) of the HDS, technical success rate (TSR) of CNB, histopathologic success rate (HSR), and complications were assessed.
Results Both the SSR of HDS and TSR of CNB were 100% (21/21). The HSR of the thyroid nodules was 85.7% (18/21). No major complications were recorded.
Conclusion HDS before CNB can successfully lead to safe biopsy of small subcapsular thyroid nodules.
Level of Evidence Level 4, Case Series

Keywords CNB · Thyroid nodules · Hydrodissection

Introduction

Core needle biopsy (CNB) was developed to improve the accuracy of thyroid nodule screening [1–3] and minimize the need for fine-needle aspiration (FNA) repetition and unnecessary surgeries. Most guidelines recommend biopsy of nodules larger than 10 mm [4–7], while the American Thyroid Association recommends FNA for nodules larger than 5 mm in high-risk patients with suspicious ultrasound (US) features [6]. Eun Ha reports that some operators oppose performing CNB due to the perceived risk of hemorrhage [8]. Several studies have shown that CNB is safe [9, 10], However, it is still a matter of concern for small nodules located deep and in close proximity to the thyroid capsule and important neck tissues. Therefore, it is essential to explore a method to safely and effectively complete CNB with the fewest complications. Hydrodissection (HDS) is used for separating the target lesion from adjacent structures during the ablation of thyroid benign nodules and cervical recurrence of papillary thyroid cancer

✉ Hojat Ebrahiminik
dr_ebrahiminik@ajaums.ac.ir

1 Department of Interventional Radiology and Radiation, Sciences Research Center, AJA University of Medical Sciences, Tehran, Iran

2 Tirad Imaging Institute, Tehran, Iran

3 Department of Radiology, Imam Reza Hospital, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran

4 Imam Khomeini Hospital, Tehran University of Medical Sciences, Tehran, Iran

5 Urmia University of Medical Sciences, Urmia, Iran

6 AJA University of Medical Sciences, Tehran, Iran

7 Shariati Hospital Department of Pathology, Tehran University of Medical Sciences, Tehran, Iran

8 Orthodontics Department, Dental School, AJA University of Medical Sciences, Tehran, Iran

to minimize injury to these structures and assist safe ablation of target lesions [11, 12].

The aim of this study was to evaluate the safety and effectiveness of CNB under the assistance of HDS.

Methods and Materials

Patients

From June 2019 to September 2020, 2325 patients were referred to the Tirad Imaging Institute for thyroid nodule biopsy. Of these, 82% underwent FNA and 18% required CNB.

In all, 21 cases (5%) in the CNB group were confirmed to have nodules in critical locations and met the criteria to be enrolled in the present study (protocol approved by the Ethical Committee of the AJA University of Medical Sciences protocol number; 9385). The inclusion criteria were as follows: thyroid nodules under 10 mm, TIRADS IV/V US feature [13], previous non-diagnostic FNA and/or history of neck irradiation, and/or a family history of thyroid malignancies. Written informed consent was obtained from all patients prior to participating in this study.

Technique of Biopsy

Before biopsy, the thyroid gland was evaluated by the US system (SuperSonic Imagine, Ultimate) using a 7–13 MHz linear probe (L10-2, L18-5). Patients were positioned supine with a hyperextended neck. After skin disinfection, local anesthesia was administered using 1–2 cc of lidocaine 1%. 0.9% saline solution was injected using a 19-G spinal needle (under US guidance) between the thyroid capsule and surrounding tissues to make a minimum physical distance of 10 mm (Figs. 1, 2, 3). Immediately after HDS, a 13 cm 18-G semi-automated biopsy core needle was inserted into the nodule under US guide in a freehand fashion with a trans-isthmic approach (lateral approach for posterior nodules; Fig. 4). Once the needle tip passed 5 mm through the nodule, the stylet and the cutting cannula were fired, respectively, and a tissue core was obtained. The needle was then removed and the tissue core sample fixed by buffered formalin at 10%. After biopsy, patients compressed the site of the biopsy for 20 to 30 min. Patients underwent US re-evaluation at 30 min, 1 h, and 7 days after CNB. The procedure was performed in the outpatient surgery of the Tirad Imaging Institute in Tehran, Iran, by an interventional radiologist with 8 years of experience.

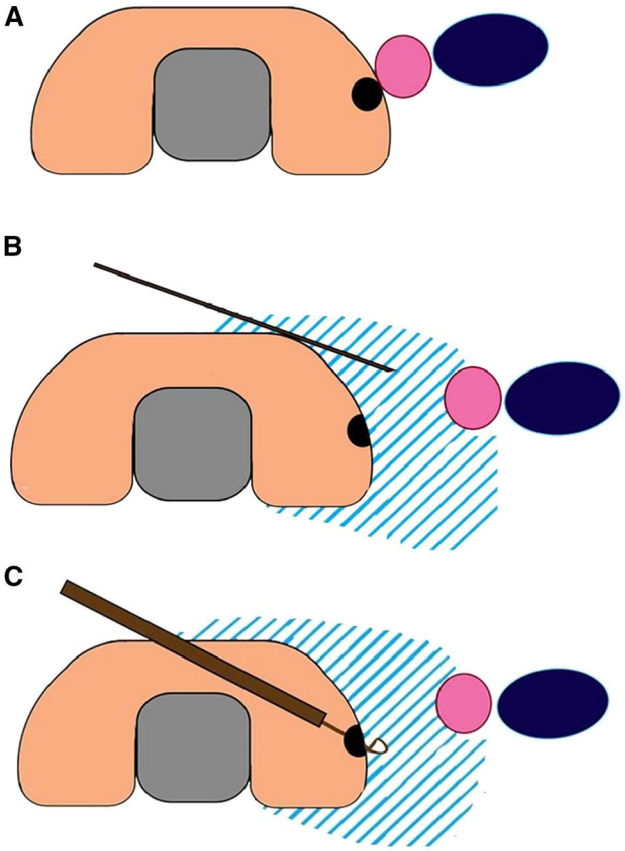

Fig. 1 Schematic illustration of Hydrodissection and core needle biopsy. **A** The close proximity of subcapsular nodule to carotid artery and jugular vein. **B** 0.9% saline injection by 19-G spinal needle for Hydrodissection**. C** Safe core needle biopsy of subcapsular nodule while the tip of 18-G needle inserted 5 mm outside the thyroid capsule without surrounding tissues injury

Success Assessment

The separation success rate (SSR) of the HDS, technical success rate (TSR) of CNB, and histopathologic success rate (HSR) were measured post procedure [14]. Separation success of HDS was defined as sufficient separation area created by 0.9% saline between the thyroid capsule and the critical surrounding tissue to reach a minimum safe margin of 10 mm. Technical success of CNB was defined as the presence of an adequate amount of specimen (at least 10 mm) observed on gross examination. Histopathologic success was defined as histopathologic diagnosis according to tissue specimens after CNB. Complications were classified based on Mauri [15].

Statistical Analysis

Results were analyzed using SPSS version 22.0. Values for quantitative variables are presented as mean ± standard deviation.

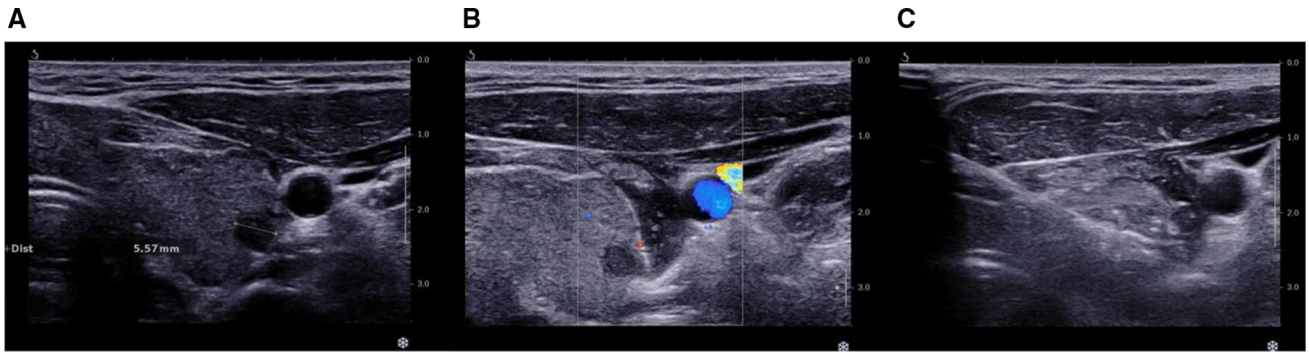

Fig. 2 CNB procedure of a lateral nodule. **A** A 5.5 mm subcapsular nodule. **B** hydrodissection. **C** Core needle biopsy with 18 G needle Note that the echogenicity of Hydrodissection area increases with time

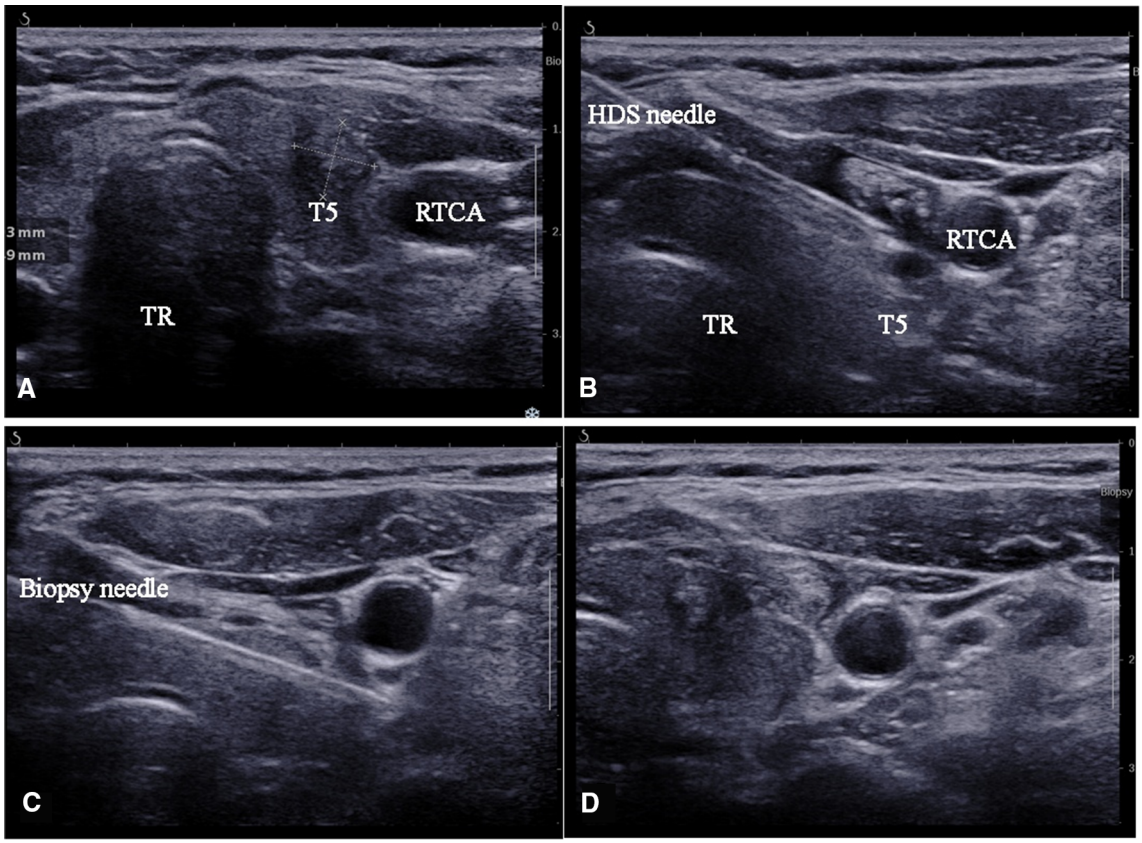

Fig. 3 CNB procedure of an anterolateral nodule. **A** A 7.8 mm nodule. **B** The 19 G spinal needle inserted for HDS. **C** The 18 G biopsy needle advanced into the nodule for biopsy. **D** US re-evaluation 30 min after the procedure, note that the HDS area disappeared and the normal saline was absorbed. Also no complication is illustrated (CNB: core needle biopsy, HDS: Hydrodissection, T5: TIRADS V, TR: Trachea, RTCA: Right Common Carotid Artery)

Results

The patient population consisted of 8 men and 13 women. The mean age was 42.5 years and the age range was 21–63 years (Table 1).

All target thyroid nodules were successfully hydrodissected from adjacent neck tissues. The SSR was 100% (21/21). The mean volume of injected 0.9% saline solution was 25.9 ± 6.0 mL. An additional amount of normal saline (up to 50 mm) was injected in four patients (19%) because of the posterior location of the nodules.

CNBs were performed at the safe margin of 10 to 21 mm and TSR of 100% (21/21) was achieved. Sampling tissue length ranged from 8 to 20 mm. The pathologic diagnosis results are shown in Table 1.

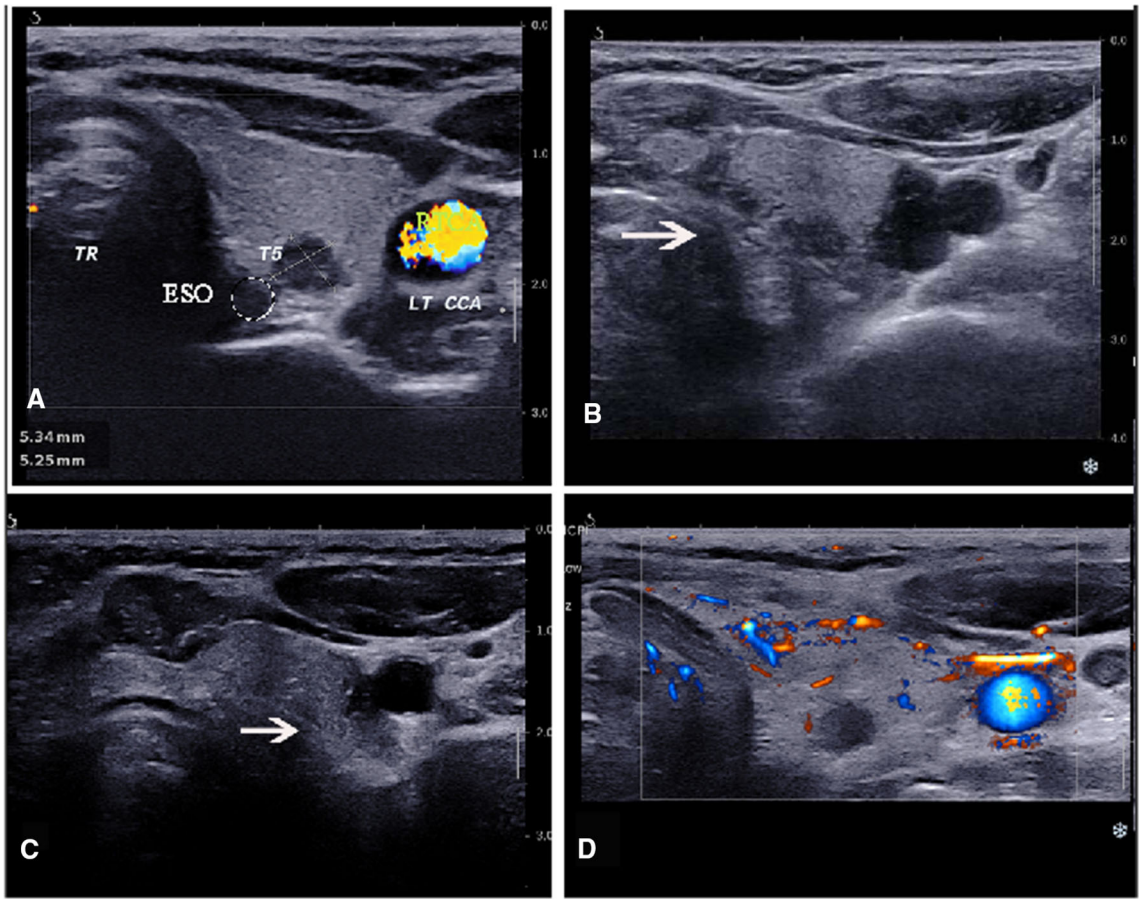

Fig. 4 CNB procedure of a posterior nodule. **A** A 5.4 mm thyroid nodule located in proximity to the esophagus (*dotted circle*). **B** Hydrodissection (arrow pointing to the 19 G needle). **C** Core needle biopsy (arrow pointing to the 18 G needle). **D** 30 min after the procedure which represents normal features with no complications (T5: TIRADS V, TR: Trachea, LT CCA: Left Common Carotid Artery, ESO: esophagus)

No major complications (grades C or D) [15] were recorded. A minor complication (grade B) was observed in one patient as a mild hematoma peripheral to the thyroid capsule after biopsy, which was managed by topical compression and completely disappeared after 7 days. The US re-evaluation at day 7 after biopsy was normal in all 21 cases.

Discussion

Although most studies of CNB in thyroid nodules are focused on nodules larger than 10 mm [5, 6, 16], the importance and cruciality of small subcapsular nodules must not be neglected due to the following reasons. First, a significant number of these small nodules are malignant. As reported by Negro, in assessment of 859 thyroid nodules, one-third of nodules diagnosed as high-risk were smaller than 10 mm [17]. Surveillance, Epidemiology, and End Results (SEER) also released information that 39% of papillary thyroid cancers diagnosed in the United States in 2008–2009 were under 10 mm [18].

Second, the biopsy procedure of small subcapsular nodules inherently carries a risk for potentially serious complications. There are several critical structures within the neck: the Common carotid arteries, the internal jugular veins, and the vagus nerve are located lateral to the thyroid lobes, and the trachea is behind the thyroid isthmus. Furthermore, the esophagus is adjacent to the posterior medial part of the left lobe [19]. During the biopsy, the slightest technical mistakes can lead to serious complications such as massive bleeding, nerve injuries and occasionally even esophageal perforation.

The complication rate of thyroid nodule biopsy has been reported to be from 1.9% to 4.1% in different studies [20, 21]. Eun Ha reported that among 6169 CNBs, 53 complications were observed, including 0.06% major and 0.79% minor complications [8], which was higher than the complication rate of the present study (0% major complications). The average size of thyroid nodules in those

Table 1 Descriptive data of the study samples

Variables	Data
No. of Patients	21
Age (mean ± SD)	42.5 ± 8.9
Gender (male/female)	8/13
US features	
TIRADS IV	6
TIRADS V	15
Nodule Size (mm)	8.1 ± 2.3
Location	
Lateral	12
Medial	5
Posterior	4
Pathology results	
PTC	12
Chronic lymphocitic thyroiditis (Hashimoto)	2
Benign Follicular nodule	4
Atypia of undetermined significance (AUS)	3
Complications	
Major	0
Minor	1

studies was 17 mm, almost twice larger than the average size of the nodules in the current study (8.2 mm).

We have proposed HDS before the CNB of nodules smaller than 10 mm in critical locations to make a safe physical distance between the thyroid capsule and adjacent structures. Zhigang Cheng proposed a similar suggestion for the biopsy of small lymph node metastases adjacent to large cervical vessels in 2019 [14].

Conclusion

To prevent damage to the perithyroidal critical structures, HDS can be used effectively and safely when CNB is needed for small subcapsular nodules.

Acknowledgements None.

Funding This study was not supported by any funding.

Declarations

Conflict of interest The authors certify that there is no conflict of interest with any individual/organization for the present work.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Also the present study protocol has been approved by the Ethical Committee Protocols of AJA University of Medical Sciences (protocol number; 9385).

Informed Consent Written informed consent was obtained from all participants included in the study.

Consent for Publication Consent for publication was obtained for every individual person's data included in the study.

References

1. Yeon JS, Baek JH, Lim HK, Ha EJ, Kim JK, Song DE, et al. Thyroid nodules with initially nondiagnostic cytologic results: the role of core-needle biopsy. Radiology. 2013;268(1):274–80.
2. Ha EJ, Baek JH, Lee JH, Kim JK, Kim JK, Lim HK, et al. Core needle biopsy can minimise the non-diagnostic results and need for diagnostic surgery in patients with calcified thyroid nodules. Eur Radiol. 2014;24(6):1403–9.
3. Na DG, Kim J-h, Sung JY, Baek JH, Jung KC, Lee H et al. Core-needle biopsy is more useful than repeat fine-needle aspiration in thyroid nodules read as nondiagnostic or atypia of undetermined significance by the Bethesda system for reporting thyroid cytopathology. Thyroid. 2012;22(5):468–75.
4. Frates MC, Benson CB, Charboneau JW, Cibas ES, Clark OH, Coleman BG, et al. Management of thyroid nodules detected at US: Society of Radiologists in Ultrasound consensus conference statement. Radiology. 2005;237(3):794–800.
5. Gharib H, Papini E, Valcavi R, Baskin HJ, Crescenzi A, Dottorini ME, et al. American Association of Clinical Endocrinologists and Associazione Medici Endocrinologi medical guidelines for clinical practice for the diagnosis and management of thyroid nodules. Endocr Pract. 2006;12(1):63–102.
6. Cooper D. American Thyroid Association (ATA) guidelines taskforce on thyroid nodules and differentiated thyroid cancer. Revised American Thyroid Association management guidelines for patients with thyroid nodules and differentiated thyroid cancer. Thyroid. 2009;19:1167–214.
7. Mendes GF, Garcia MR, Falsarella PM, Rahal A, Cavalcante Junior FA, Nery DR et al. Fine needle aspiration biopsy of thyroid nodule smaller than 1.0 cm: accuracy of TIRADS classification system in more than 1000 nodules. Br J Radiol. 2017;91(xxxx):20170642.
8. Ha EJ, Baek JH, Lee JH, Kim JK, Choi YJ, Sung TY, et al. Complications following US-guided core-needle biopsy for thyroid lesions: a retrospective study of 6,169 consecutive patients with 6,687 thyroid nodules. Eur Radiol. 2017;27(3):1186–94.
9. Baloch ZW, Cibas ES, Clark DP, Layfield LJ, Ljung B-M, Pitman MB, et al. The National Cancer Institute Thyroid fine needle aspiration state of the science conference: a summation. Cytojournal. 2008;5:6.
10. Jung CK, Baek JH, Na DG, Oh YL, Yi KH, Kang H-C. 2019 Practice guidelines for thyroid core needle biopsy: a report of the Clinical Practice Guidelines Development Committee of the Korean Thyroid Association. J Pathol Transl Med. 2020;54(1):64.
11. Lim HK, Baek JH, Lee JH, Kim WB, Kim TY, Shong YK, et al. Efficacy and safety of radiofrequency ablation for treating locoregional recurrence from papillary thyroid cancer. Eur Radiol. 2015;25(1):163–70.
12. Cheng Z, Che Y, Yu S, Wang S, Teng D, Xu H, et al. US-guided percutaneous radiofrequency versus microwave ablation for benign thyroid nodules: a prospective multicenter study. Sci Rep. 2017;7(1):1–10.

13. Kwak JY, Han KH, Yoon JH, Moon HJ, Son EJ, Park SH, et al. Thyroid imaging reporting and data system for US features of nodules: a step in establishing better stratification of cancer risk. Radiology. 2011;260(3):892–9.
14. Cheng Z, Liang P. US-guided core needle biopsy under assistance of hydrodissection to diagnose small lymph node metastases adjacent to cervical large vessels. Diagn Interv Radiol. 2019;25(2):122.
15. Mauri G, Pacella CM, Papini E, Solbiati L, Goldberg SN, Ahmed M, et al. Image-guided thyroid ablation: proposal for standardization of terminology and reporting criteria. Thyroid. 2019;29(5):611–8.
16. Kwak JY. Indications for fine needle aspiration in thyroid nodules. Endocrinol Metab. 2013;28(2):81–5.
17. Negro R, Greco G, Colosimo E. Ultrasound risk categories for thyroid nodules and cytology results: a single institution's experience after the adoption of the. update of medical guidelines by the American Association of Clinical Endocrinologists and Associazione Medici Endocrinologi. J Thyroid Res. 2016;2017:2017.
18. Davies L, Welch HG. Current thyroid cancer trends in the United States. JAMA Otolaryngol Head Neck Surg. 2014;140(4):317–22.
19. Choi SH, Kim E-K, Kim SJ, Kwak JY. Thyroid ultrasonography: pitfalls and techniques. Korean J Radiol. 2014;15(2):267–76.
20. Paja M, del Cura JL, Zabala R, Korta I, Ugalde A, López JI. Core-needle biopsy in thyroid nodules: performance, accuracy, and complications. Eur Radiol. 2019;29(9):4889–96.
21. Jeong EJ, Chung SR, Baek JH, Choi YJ, Kim JK, Lee JH. A comparison of ultrasound-guided fine needle aspiration versus core needle biopsy for thyroid nodules: pain, tolerability, and complications. Endocrinol Metab. 2018;33(1):114–20.