CASE REPORT

Application of shear wave elastography in fine needle aspiration biopsy for thyroid nodule

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Abstract

Ultrasound guided fine needle aspiration biopsy (FNAB) is the first-line procedure in diagnosing thyroid nodules. However, emerging studies have reported its unsatisfactory cell sample for cytology evaluation. In this case report, shear wave elastography (SWE) guided FNAB on a thyroid nodule is presented. Biopsies were performed on both hard and soft areas of the same nodule on the SWE image. Cytological results demonstrated the sufficient diagnostic components and typical nuclear features of papillary carcinoma found on the specimen from the hard area. This case study indicates SWE is a useful complementary tool to conventional B-mode ultrasound in guiding thyroid nodule FNAB.

Keywords: Thyroid nodule, Fine needle aspiration biopsy, Shear Wave Elastography.

Introduction

Ultrasound guided fine needle aspiration biopsy (FNAB) proves to be the most economical and reliable diagnostic procedure to identify thyroid nodules that need surgical excision.[1-3] Adequate or representative cell sample is the key to successful thyroid nodule FNAB. However, recent studies have shown that ultrasound guided FNAB has significant unsatisfactory cell sample for cytology evaluation[4] and high false negative cytology in diagnosing malignancy, especially for thyroid nodules if or more than 4 cm.[5] In this case report, a newly developed shear wave elastography (SWE) is employed in guiding a thyroid nodule FNAB. Biopsies were carried out on both hard and soft areas of the same nodule in the elasticity map. No significantly different echotextures on the B-mode ultrasound image were found between the two biopsy sites. The cytological results demonstrated that the sufficient diagnostic components and typical nuclear features of papillary carcinoma were found on the specimens from the hard area. In contrast, the specimens from the soft area presented inadequate cellularity and features for diagnosing papillary carcinoma. This case study indicates SWE is a useful complementary tool to conventional B-mode ultrasound in guiding thyroid nodule FNAB.

Case Report

On May 2013, a 49-year-old woman incidentally came to the hospital for thyroid examination. No palpable mass was revealed during the neck examination. Laboratory examinations including triiodothyronine (T3) and thyroxine (T4) exhibited normal thyroid function. No family history of thyroid diseases was present.

Ultrasound findings: Thyroid ultrasound screening was performed using an iU22 ultrasound system equipped with a 12-5 MHz linear transducer (Royal Philips, the Netherlands) by an experienced intervention ultrasound

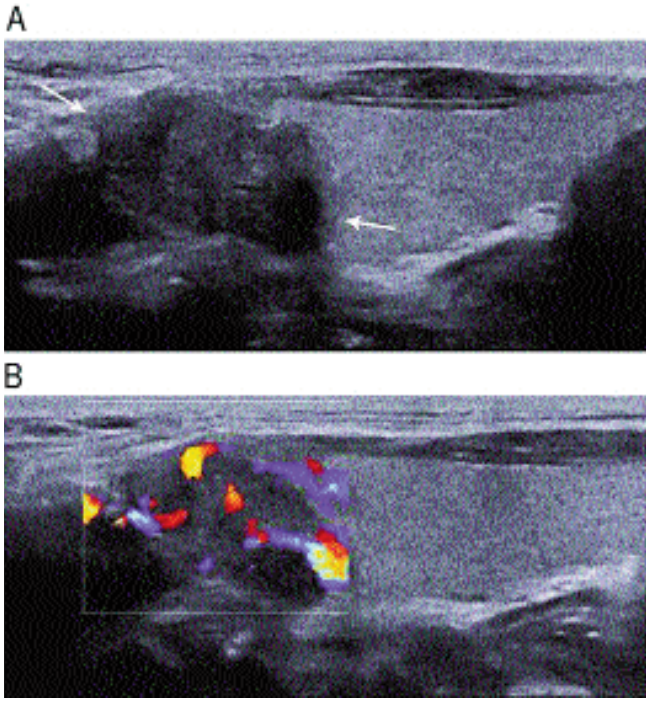

Figure-1: Longitudinal sonographies of the right thyroid gland. A) Conventional B-mode ultrasound image presents an ill-defined hypo-echoic nodule in the upper pole of the right thyroid gland. B) Color Doppler examination of the nodule reveals both perinodular and intranodular vascularity.

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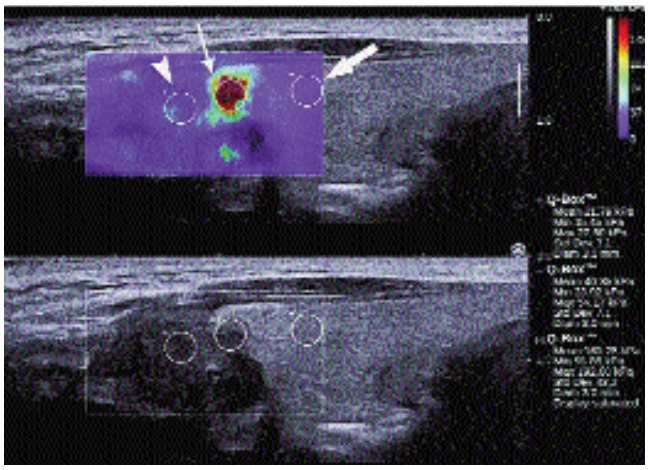

Figure-2: SWE examination results of the right thyroid gland accessed by longitudinal scan with SWE image on the top and B-mode ultrasound image on the bottom. In the SWE image, the estimated tissue stiffness values within the fixed rectangular are colored coded; and the statistics of measurements within the circle regions of interest are displayed on the right of the image.

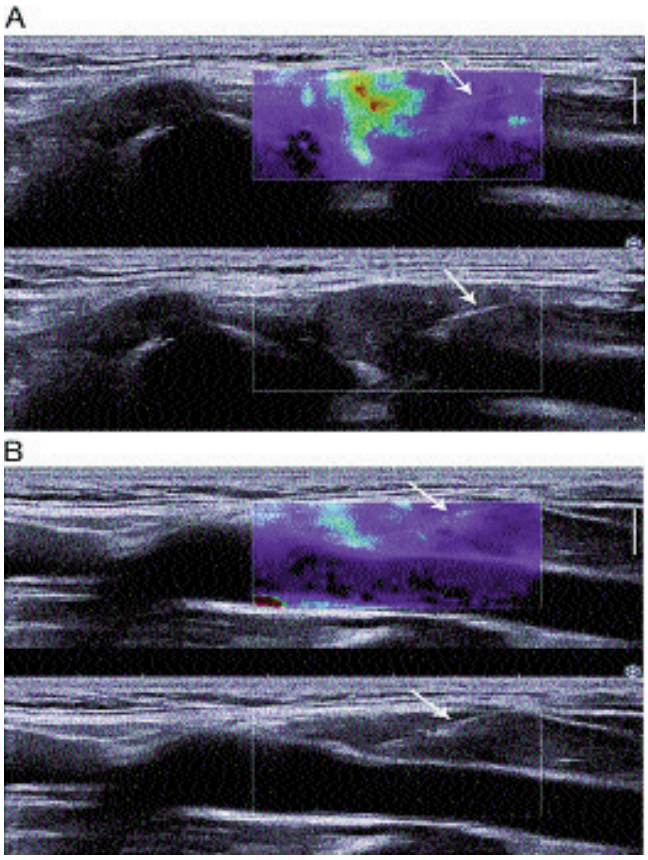

Figure-3: Fine needle aspiration biopsies on the hard and soft areas inside the nodule on the SWE image. A) SWE transversal sonography guiding biopsy on the hard area of the nodule. B) SWE longitudinal sonography guiding biopsy on the softer area of the nodule.

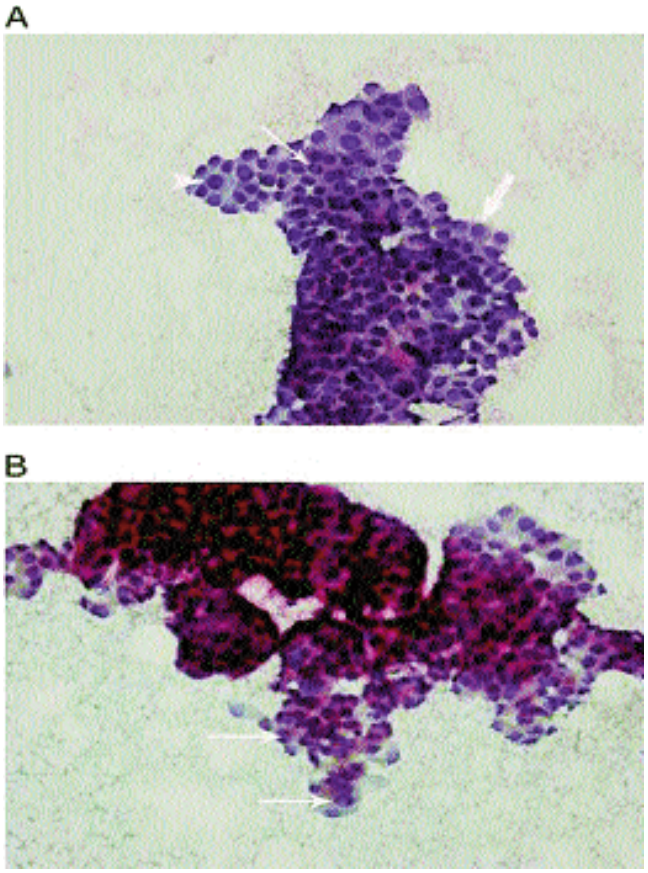

Figure-4: Papanicolaou-stained cytology images (× 400) for two specimens from the hard area of the nodule on the SWE image. Follicular cells are arranged in the papillary formation and typical nuclear features of thyroid papillary carcinoma are exhibited. A) Papanicolaou-stained cytology image in the specimen I shows typical nuclear envelope irregularity (short arrow), Annie Eye nuclei (thin arrows) and fine chromatin texture (thick arrow). B) Papanicolaou-stained cytology image in the specimen II shows typical prominent intranuclear inclusions (thin arrows).

physician (Y.M.). B-mode trans-sonography revealed normal size and iso-echotexture of the bilateral thyroid. However, the longitudinal sonography demonstrated an ill-defined hypo-echoic nodule in the upper pole of the right thyroid gland, with size of 17×14×11mm. The border of the nodule was not clearly demarcated with slight peripheral calcification and its internal echogenicity was heterogeneous (Figure-1A). In the colour Doppler examination, both peri-nodular flow and chaotically arranged intra-nodular flow were observed (Figure-1B).

Elastography findings: Shear wave elastography (SWE) was utilized to access the elastic properties of the thyroid nodule and its surrounding tissue using a 15-4 MHz super linear transducer (Supersonic imagine, France). The SWE examination was carried out by the same ultrasound physician (Y.M.) as in the conventional ultrasound

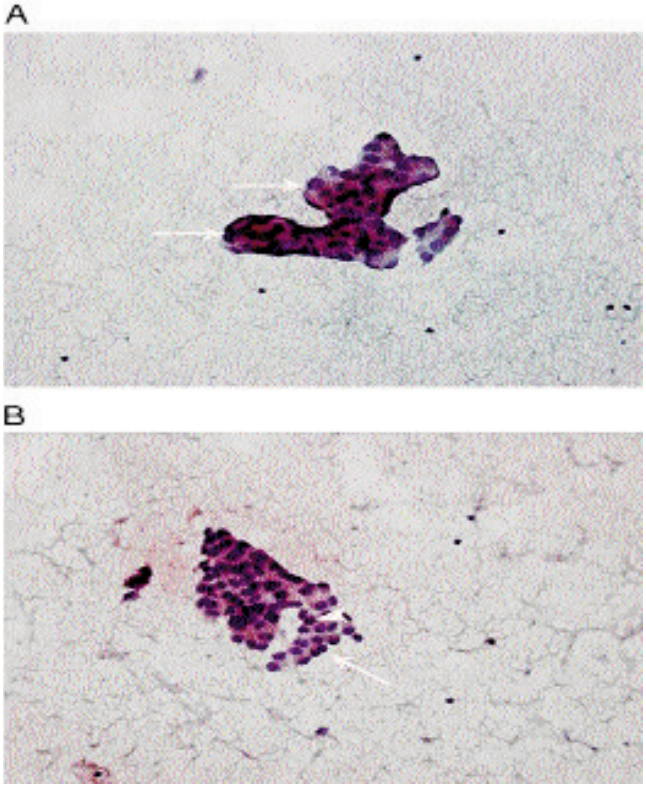

Figure-5: Papanicolaou-stained cytology images (× 400) for two specimens from the soft area of the nodule on the SWE image. A) Papanicolaou-stained cytology image in the specimen I shows a few follicular cells arranged in a papillary pattern (thin arrow). B) Papanicolaou-stained cytology images in the specimen II reveals elongated nuclei and intranuclear grooves (short arrow).

examination. Figure-2 shows SWE (top) and B-mode ultrasound (bottom) images on the thyroid nodule examination. No clear nodule boundary was identified on the SWE image as compared with that on the B-mode ultrasound image. Heterogeneous stiffness distribution was revealed inside the nodule. Three areas with significantly different mean stiffness values within the nodule and its surrounding tissue were depicted on the SWE image. The stiffness statistics (mean, maximum, minimum and standard deviation) were displayed on the right side of the image. Significant higher mean stiffness value was found inside the nodule (mean stiffness value of 40.35 kPa) as compared with its surrounding tissue (mean stiffness value of 21.79 kPa).

SWE guided FNAB on thyroid nodule: On the SWE image (Figure-2: top), two areas inside the nodule, dark red hard area (mean stiffness value of 161.28 kPa) and light blue soft area (mean stiffness value of 40.35 kPa), were chosen as the two biopsy sites. No different echotextures were found between the two biopsy sites on B-mode ultrasound image (Figure-2: bottom). Multiple biopsies were performed on the two biopsy sites with a 22-gauge fine needle and aided by a 10mL plastic syringe, respectively (Figure-3A and Figure-3B). For each biopsy, 0.5mL tissues were aspirated. The aspirated tissues were placed on the labeled glass slides for the cytology examinations.

Cytology findings: Papanicolaou-stained cytology images (× 400) for the specimens from the hard and soft areas were shown in Figure-4 and Figure-5, respectively. The cytology images were interpreted and diagnosed by an experienced pathologist on thyroid cancer (Y. S.). Follicular cells were arranged in the papillary formation on the slices from the hard area and typical nuclear features of papillary thyroid carcinoma were presented with crowed ovoid nuclei, Annie Eye nuclei (thin arrow in Figure-4A), fine chromatin texture (thick arrow in Figure-4A), nuclear envelope irregularity (short arrow in Figure-4A), prominent intranuclear inclusions (thin arrow in Figure-4B) and nuclear grooves. While on the slices from the soft area, very few nuclei were revealed and insufficient diagnostic features were exhibited (Figure-5A and Figure-5B).

Discussion

Ultrasound guided FNAB remains the primary method in the evaluation of thyroid nodules. It can discriminate malignant from benign thyroid nodules. Compared to the blind puncture, ultrasound guided FNAB can target non-palpable nodules and more representative biopsy sites of palpable nodules by avoiding the cystic or necrotic areas.[1-3] However, its diagnostic accuracy is limited by the frequent invalid sampling. In the study of Lee in 2008,[4] around 40% of the biopsies were either non-diagnostic or indeterminate with paucities of cellularity. Therefore, new imaging guidance methods are highly expected in clinical practice to pursuing more accurate FNAB in thyroid nodules.

Tissue elasticity or stiffness reveals the biological and mechanical property of a soft tissue that depends on its molecular components and internal structure.[6-8] Tissue elasticity has proved to be a useful predictor for malignancy in thyroid, prostate and breast cancers.[9-11] Recently, shear wave based elastography (SWE) has been developed to quantify the elastic properties of soft tissues.[12-14] Sebag et al in 2010 reported significantly higher stiffness values on malignant thyroid nodules (150 ± 95 kPa) than on benign nodules (36±30kPa).[15] In this study also significantly higher mean stiffness value found inside the malignant nodule (mean stiffness value >40.35kPa) as compared with the surrounding tissue (mean stiffness value of 21.79kPa). To explore additional clinical utilities of SWE, a newly

developed shear wave elastography was employed in guiding a thyroid nodule FNAB.[12]

In this case report, no palpable thyroid nodule was found on the patient during the physical examination. Patient visited the hospital for regular whole body examination as per her annual body examination. She was advised thyroid ultrasound examination. In China, the incidence of thyroid cancer is increasing day by day. Thyroid cancer awareness amongst the Chinese population has also been increased. As a result a lot of people visiting hospital annually for whole body screening examination on their own or are sent by the organization where they work. Early detection of thyroid cancer improves the outcome and survival and then remains the cornerstone of thyroid cancer control.[16] In this case, via conventional B-mode ultrasound screening, an ill-defined hypo-echoic nodule with 17×14×11 mm was revealed on the right thyroid gland. The colour Doppler examination showed peri-nodular flow and chaotically arranged intra-nodular flow on the nodule. However, the ultrasound findings were not sufficient enough to define the nature of the nodule. Therefore, FNAB on the thyroid nodule was recommended to further determine its nature. Before the biopsy, SWE examination was carried out to investigate the elastic properties of the nodule and its surrounding tissue. On the SWE image, both hard and soft areas within the nodule with significant different stiffness properties were chosen as the two biopsy sites. As demonstrated by the cytology results, the specimens from the hard area had strong diagnostic components and typical nuclear features in diagnosing papillary carcinoma. In contrast, the specimens aspirated from the soft area inside the nodule showed insufficient nuclear features in diagnosing malignancy. Thus results of this report imply that the differences in the cellular formation and cellular structure could influence the tissue elasticity and therefore be characterized by SWE.

Conclusion

Shear wave based elastography can provide elasticity information of soft tissue in diagnosing malignant thyroid nodule. This case study demonstrates that SWE can also be used as a complementary tool to the conventional B-mode ultrasound in the guidance of thyroid nodule FNAB.

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