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Application of Ultrasound-Guided Core Biopsy to Minimal-Invasively Diagnose Supraclavicular Fossa Tumors and Minimize the Requirement of Invasive Diagnostic Surgery

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Abstract: Tumors of the supraclavicular fossa (SC) is clinically challenging because of anatomical complexity and tumor pathological diversity. Because of varied diseases entities and treatment choices of SC tumors, making the accurate decision among numerous differential diagnoses is imperative. Sampling by open biopsy (OB) remains the standard procedure for pathological confirmation. However, complicated anatomical structures of SC always render surgical intervention difficult to perform. Ultrasound-guided core biopsy (USCB) is a minimally invasive and office-based procedure for tissue sampling widely applied in many diseases of head and neck. This study aims to evaluate the clinical efficacy and utility of using USCB as the sampling method of SC tumors. From 2009 to 2014, consecutive patients who presented clinical symptoms and signs of supraclavicular tumors and were scheduled to receive sampling procedures for diagnostic confirmation were recruited. The patients received USCB or OB respectively in the initial tissue sampling. The accurate diagnostic rate based on pathological results was 90.2% for USCB, and 93.6% for OB. No significant difference was noted between USCB and OB groups in terms of diagnostic accuracy and the percentage of inadequate specimens. All cases in the USCB group had the sampling procedure completed within 10 minutes, but not in the OB group. No scars larger than 1 cm were found in USCB. Only patients in the OB groups had the need to receive general anesthesia and hospitalization and had scars postoperatively. Accordingly, USCB can serve as the first-line sampling tool for SC tumors with high diagnostic accuracy, minimal invasiveness, and low medical cost.

Abbreviations: CD = cluster of differentiation, FNA = fine needle aspiration, HE staining = hematoxylin and eosin staining, MRI = magnetic resonance imaging, OB = open biopsy, SC = supraclavicular fossa, USCB = ultrasound-guided core biopsy.

INTRODUCTION

The supraclavicular fossa (SC) is clinically regarded as a complicated anatomical region because it is located above the clavicle and composed of intricate tissues. Many important organs such as vessels, nerve trunks, and lymphatics reside in the SC. Consequently, tumors identified in SC may have distinct nature. For example, metastatic lymph nodes found in the SC as initial clinical presentation are frequently encountered. They may originate from the head and neck, the lung, the breast, the gastrointestinal tract, or the genitourinary system.[1,2] Therefore, making the correct diagnosis of SC tumors is imperative.

Conventionally, SC tumors are diagnosed mainly based on the procedure of open biopsy (OB). During the operation, appropriate exposure of surgical field is necessary to protect neighboring organs and structures. It is challenging when a small wound is created for biopsy. In addition, the operative procedure and postoperative wound care are always required and thus increase medical cost. On the other hand, fine needle aspiration (FNA) is a sampling method with minimal invasiveness widely applied in the head and neck. It has also been used as the routine procedure to diagnose SC tumors.[1] However, only cytological information obtained from FNA. Experienced cytopathologists and immediate cytological examination are necessary to improve diagnostic accuracy.[3] For SC tumors with numerous differential diagnoses, the cytological reports showing only positivity or negativity of malignancy is inadequate for clinical decision. It is therefore the OB procedure is always suggested after FNA, which prolongs the time and increases the cost for diagnosing SC tumors.

Ultrasound-guided core biopsy (USCB) had been widely used clinically because of minimal-invasiveness, real-time monitoring, an office-based procedure, and low medical cost. Particularly in head and neck, USCB has drawn increasing attention because it can minimize the need of operations in making the differential diagnosis of head and neck tumors, and prevent patients from suffering procedures and associated complications of surgery.[4] Since SC tumors are complicated, potentially malignant, and pathologically diverse, how to confirm the accurate diagnosis in an efficient and minimally invasive way is clinically important. Especially for the diseases

exclusively treated without surgery, such as lymphoma and tuberculosis, USCB may serve as a useful alternative diagnostic tool supplementary to the current diagnostic protocol. In this study, we had recruited consecutive patients presenting with SC tumors who had received USCB as the first-line diagnostic procedure. Our results demonstrated the utility of USCB in diagnosing a variety of SC tumors with accuracy and benefits. USCB is therefore suggested to serve as the first-line diagnostic tool of SC tumors.

MATERIALS AND METHODS

Patients

From 2009 to 2014, consecutive patients who presented clinical symptoms and signs of supraclavicular tumors and were scheduled to receive sampling procedures for diagnostic confirmation were recruited. This study was approved by the Research Ethnic Committee of National Taiwan University Hospital. The exclusion criteria included previous sampling procedure of SC tumors, patients refused invasive procedures, and patients failed to follow-up after the procedure. The patients were scheduled for USCB or OB respectively for the initial first trial tissue sampling. Only those with inconclusive results were scheduled to receive repetitive procedures of OB (Figure 1). The demographic and clinical information of all enrolled patients were reviewed.

Ultrasound-Guided Core Biopsy (USCB)

The patient was placed in a supine position. Ultrasound machinery (Hitachi HI VISION Avius®, Soto-kanda, Chiyoda-ku, Tokyo, Japan/Toshiba Aplio SSA790 diagnostic ultrasound system, Tochigi-ken, Japan) with a 12 MHz linear array transducer was used for USCB procedure. Standard ultrasound examination over head and neck was first performed, and the location of SC tumor was cautiously identified. Surrounding vessels, nerves, and organs were avoided by Power-Doppler color imaging. By this way, the safe path for USCB needle introduction was planned. If the ultrasound showed tumor features with multiple cystic components, fluid was removed by aspiration and USCB was used to target the remaining solid components for tumor sampling. The procedures of USCB were performed or supervised by senior operators (C.N. Chen, C.Y. Lin, and T.L. Yang). Under echo-guidance, 18-gauge biopsy needles (Temno Evolution Biopsy Devices; Cardinal Health Inc., Dublin, OH, USA) were used for specimen harvest. Local anesthesia was injected subcutaneously around the core needle puncture site as previously described.[5,6] Bleeding was controlled with pressure for minutes, and the whole procedure completed within 10 minutes. The specimens were sent for standard pathological examinations (Figures 2–4).

Techniques of Open Biopsy

The patient was set in a supine position with neck hyperextension. The supraclavicular area exposed and a skin incision was made along the skin crease. The length of wound depended on the tumor size and location. The skin and underlying soft tissue were separated layer by layer to expose the SC tumor. Either incisional or excisional biopsies were performed where appropriate, followed by hemostasis and wound closure of the standard manner (Figure 5).

Pathological Examination

The harvested specimens of SC tumors were sent to the Department of Pathology, National Taiwan University Hospital for standard processing. The specimens were evaluated by the standard pathological examinations, including hematoxylin–eosin (HE) stain and immunohistochemical stain. The slides of
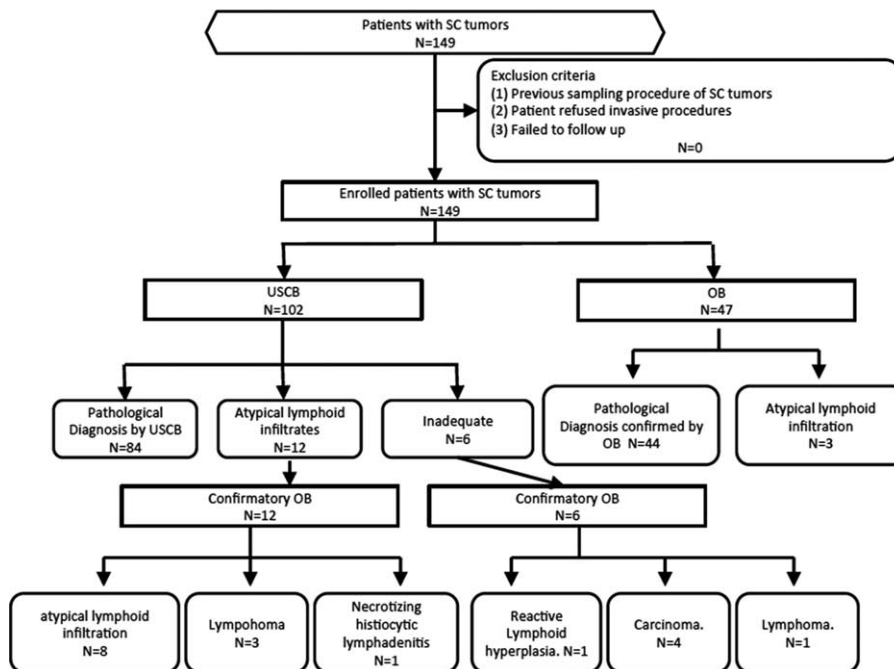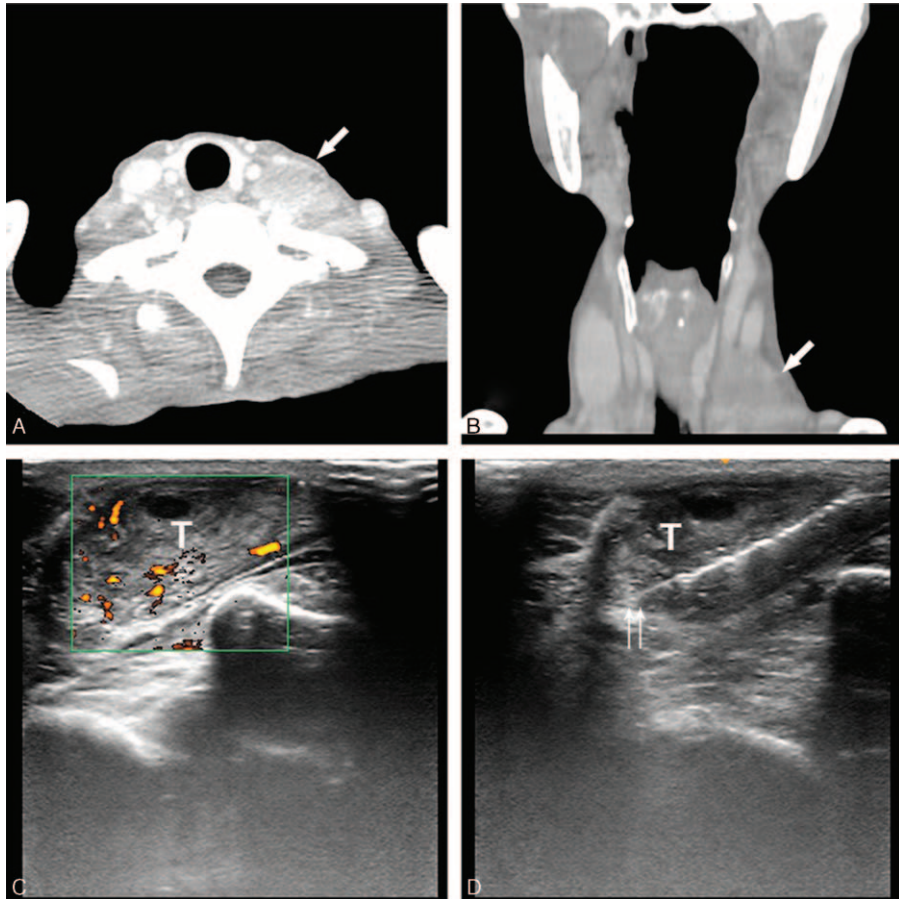

FIGURE 1. The flowchart of inclusion and exclusion criteria in enrolled patients. USCB, ultrasound-guided core biopsy; OB, open biopsy; SC, supraclavicular fossa.

FIGURE 2. Ultrasound imaging and the procedure of USCB in diagnosing SC tumors. (A) The axial view of CT images and (B) the coronal view demonstrated a tumor with heterogeneously contrast enhancement (white arrow) located at the left supraclavicular fossa. (C) Ultrasound imaging revealed the hypoechoic nature of tumor (T) with punctate vascularity. (D) USCB was performed for tumor tissue harvest (double arrows: tip of the core needle).

all specimens were reviewed by independent pathologists blind to clinical information.

Statistical Analysis

For statistical analyses, the numerical data were analyzed by *t* test, and categorical data were compared by Fisher exact test and Chi-square test where appropriate. For analyzing the factors of SC tumors pertinent to the accuracy of pathologically confirmed diagnosis of initial sampling, logistic regression was performed for USCB and OB groups. The statistical significance was set at $P < 0.05$. Statistical analysis was performed using SPSS software.

RESULTS

In this study, 102 patients who had SC tumors and received USCB were enrolled. There were 50 male and 52 female patients. Their ages ranged from 18 to 91 years, with a mean age of 53.86 years. Among all patients, 96 cases were pathologically diagnosed by USCB, including 51 cases of malignancy (45 belonged to epithelial origins whereas 6 belonged to hematopoietic origins), 33 cases with benign tumors, 12 cases with atypical lymphoid infiltrates. The details of all demographic and pathological data are listed in Table 1.

Another 47 cases with SC tumors that had received OB for sampling were enrolled for comparison. There were 28 male and 19 female patients. The average age was 50.82 years. For pathological findings, 24 were diagnosed as malignancy with 13 epithelial and 10 hematopoietic origins. There were 20 cases diagnosed as benign, while 3 cases were reported as atypical lymphoid infiltrates. No case was found to have inadequate specimens (Table 2). Comparison of demographic information and clinical presentation of SC tumors in USCB and OB group are demonstrated in Table 3. No significance differences were found regarding the demographic and clinical factors between these 2 groups.

For the USCB group, the accurate diagnoses were made in 90.2% patients. In OB group, the accurate diagnoses were confirmed in 93.6% cases. There was no significant difference between USCB and OB groups in terms of diagnostic accuracy. There were 6 cases with inadequate specimens in USCB group whereas no any case in OB group. However, no statistical significance was found. 11.8% cases in USCB group and 6.4% of OB group were diagnosed as atypical lymphoid infiltrate, without statistical significance in difference (Table 4). Regarding the factors of SC tumors pertinent to the accuracy of pathologically confirmed diagnosis of initial sampling, the analysis was performed between USCB and OB groups
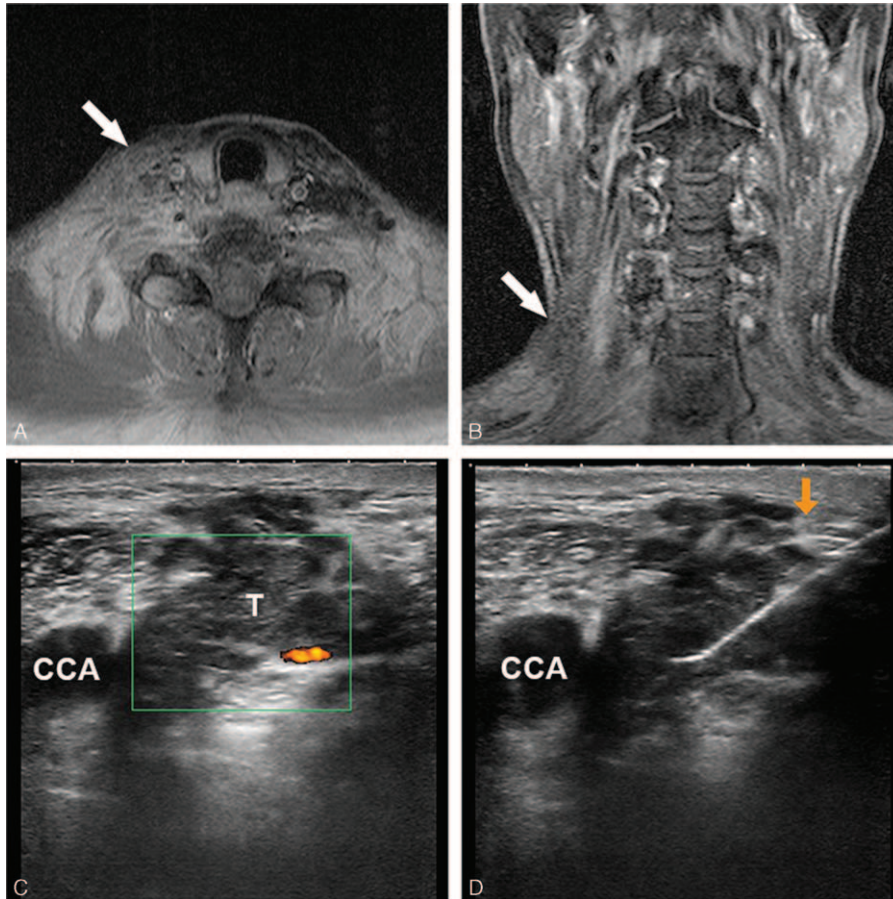
FIGURE 3. Ultrasound imaging and the procedure of USCB in diagnosing SC tumors close to the great vessel. (A) The axial view and (B) the coronal view of T1WI MRI showed an ill-defined and heterogeneous tumor (white arrow) located in the right supraclavicular fossa. (C) The ultrasound demonstrated that the SC tumor (T) is adjacent to the common carotid artery (CCA). (D) USCB was performed for sampling of the SC tumor without CCA perturbation (orange arrow).

(Table 5). There were no factors significantly affecting sampling accuracy in both groups.

All cases in USCB group had whole procedures completed within 10 minutes. All procedures performed for OB were more than 10 minutes, ranging from 12 to 76 minutes. After USCB, only a tiny puncture wound could be found immediately after the procedure, without leaving any scars thereafter. All cases in the OB group had scars more than 1 cm (Figures 4 and 5). All cases in USCB group received only local anesthesia during the procedure, whereas three cases of OB group received biopsies under general anesthesia because of deep-seated tumors. These cases are therefore requested for hospitalized observation (Table 6).

There were 18 cases received both procedures of USCB and OB (initial USCB and then OB). Twelve were atypical lymphoid infiltrates and 6 were inadequate specimens. In the 12 cases with atypical lymphoid infiltrates, 8 cases still showed atypical lymphoid infiltrates in OB, but the other 4 cases had unmatched results, including 3 lymphoma and 1 necrotizing histocytic lymphadenitis. Among the 6 cases with inadequate specimens by USCB, 5 finally were proved malignancy (4 carcinoma and 1 lymphoma) by OB and the remaining 1 was diagnosed as reactive lymphoid hyperplasia (Figure 1).

DISCUSSION

In this study, we demonstrated the clinical utility of applying USCB in diagnosing SC tumors in a variety of differential diagnoses. USCB is a useful diagnostic tool because of minimal invasiveness, preciseness, real-time monitoring, and an office-based procedure, which benefits both patients and physicians by reducing labor and cost of diagnoses.[5–8] Application of USCB can reduce the need of diagnostic surgery, particularly useful for the patients who are vulnerable or contra-indicated for invasive surgical procedure.[7,9,10] Even for the cases with deep-seated SC tumors, which are usually clinical challenges for OB, tumor sampling can be easily and successfully approached by USCB without the need of general anesthesia. Contrary to FNA, pathological information can be obtained by USCB, a standard to confirm the final diagnosis of tumors. It is also feasible to do immunohistochemical staining in the specimens harvested by USCB (Figures 6 and 7).[11] The data further differentiate the possible diagnoses, and render characterization of tumor subtype feasible.

FNA is usually used as the diagnostic sampling of SC tumors, but its diagnostic yield is around 70% based on previous reports.[12,13] Only cytological reports are insufficient to finalize clinical decisions. Even for the benign SC lesions, differential

FIGURE 4. The USCB procedure of SC tumors. (A) USCB was performed under ultrasound guidance by a free hand method. (B) The needle was inserted along the axis of the linear probe. (C) Only a puncture wound was left without any additional sutures (arrow). (D) Bleeding was easily controlled by the standard compression maneuver (arrow).
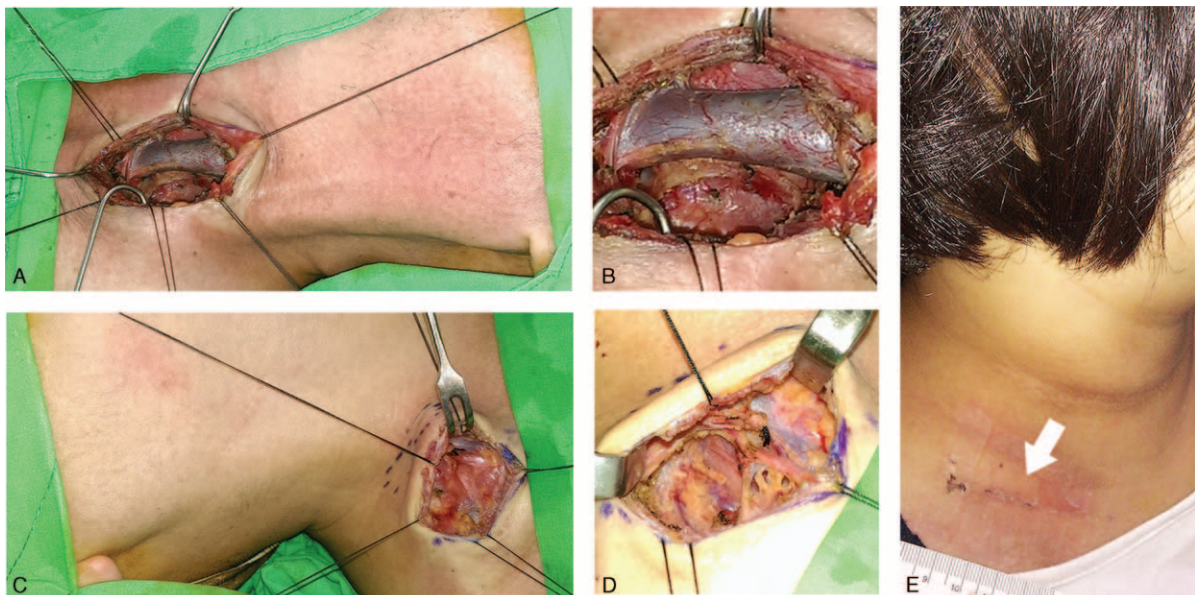
FIGURE 5. The OB procedure for SC tumors. (A) An OB procedure was performed for a SC tumor located adjacently to the great vessels. (B) The internal jugular vein was exposed in a close view during OB procedure. (C) An OB procedure was performed for a SC tumor located close to the nerve trunk. (D) The nerve branches and vessels were identified during the OB procedure. (E) An obvious scar was left in the SC area after the OB procedure for tumor sampling (arrow).

TABLE 1. Demographic Data and Pathological Presentation of Supraclavicular Fossa Tumors Sampled by Ultrasound-Guided Core Biopsy

Total cases	102
Age	53.86 ± 16.56
Gender (M:F)	50:52
USCB diagnosis	
Malignant	51
Hematopoietic origin	6
Hodgkin lymphoma	1
Diffuse large B cell lymphoma	2
Follicular lymphoma	1
Small lymphocytic lymphoma	1
Lymphoma (unclassified)	1
Epithelial origin	45
Adenocarcinoma (7 lung and 1 thyroid origin)	13
Squamous cell carcinoma	10
Papillary carcinoma	2
Invasive ductal carcinoma	1
Carcinoma (1 breast, 1 liver, and 1 prostate origin)	19
Benign	33
Granulomatous inflammation (3 Caseating granulomatous inflammation)	14
Acute and chronic inflammation	4
Necrotizing histiocytic lymphadenitis (Kikuchi disease)	2
Necrosis (1 mycobacteria infection)	4
Proliferative fibroblastic/ myofibroblastic lesion	1
Schwannoma	1
Benign lymphoid tissue	7
Atypical lymphoid infiltrates	12
Inadequate specimens	6

F = female, M = male, USCB = ultrasound-guided core biopsy.

TABLE 2. Demographic Data and Pathological Presentation of Supraclavicular Fossa Tumors Sampled by Open Biopsy

Total cases	47
Age	50.82 ± 21.13
Gender (M:F)	28:19
OB diagnosis	
Malignant	24
Hematopoietic origin	10
Hodgkin lymphoma	2
Diffuse large B cell lymphoma	4
Follicular lymphoma	2
Mature B cell lymphoma	1
Small lymphocytic lymphoma/ chronic lymphocytic leukemia	1
Epithelial origin	13
Adenocarcinoma (1 colonic origin)	2
Metastatic carcinoma	11
Epithelioid angiosarcoma	1
Benign	20
Caseating granulomatous inflammation (6 acid-fast stain positive)	10
Acute and chronic inflammation	1
Reactive lymphoid hyperplasia	7
IgG4-related lymphadenopathy	1
Spindle cell lipoma	1
Atypical lymphoid infiltrates	3
Inadequate specimens	0

F = female, M = male, OB = open biopsy.

were finally diagnosed as malignancy. Compatible with previous studies, the demographic data revealed the ominous nature of SC tumors. A case presented in our series had history of nasopharyngeal carcinoma with curative treatment (Figure 6). When a SC tumor was found during a routine follow-up, USCB was performed for the SC tumor. The

diagnosis such as Kikuchi-Fujimoto disease, caseating granulomatous inflammation, or reactive lymphoid hyperplasia should be accurately made for treatment. Based on our previous work, it could be successfully and easily achieved by USCB rather than FNA.[7,14] Although some progress had been made in the preparation and reading of specimens harvested by FNA, such as rapid on-site evaluation, telecytopathology, or ultrasound-guided FNA with cell block,[15] the nondiagnostic rate of FNA only slightly reduces and is not better than USCB.[16,17] Furthermore, the incidence of procedure-related complications is not different in both procedures.[18]

USCB is superior to FNA in diagnosing SC tumors based on the pathological examinations. The specimens harvested by USCB are not only used to confirm malignancy of tumor, but also provide pathological features for identifying the potential primary sites. Lymph node metastasis is frequently found in SC, no matter originating from head and neck, or other anatomical parts such as the breast, the lung, and the gastrointestinal tract. SC lesions are therefore notorious for lymph node metastasis and had been named as Virchow node. SC tumors may serve as sentinels for malignancy detection. In our study, 50% cases

TABLE 3. Comparison of Demographic Information and Clinical Presentation of Supraclavicular Fossa Tumors in the Groups of Ultrasound-Guided Core Biopsy and Open Biopsy

	USCB (n = 102)	OB (n = 47)	*P*-Value
Age (years)	53.86 ± 16.56	50.82 ± 21.13	0.352
Sex (M:F)	50:52	28:19	0.231
Side (L:R)	58:44	29:18	0.578
Long axis (cm)	2.10 ± 0.79	2.31 ± 1.30	0.291
Short axis (cm)	1.46 ± 0.63	1.66 ± 1.07	0.248
L/S axis ratio	1.51 ± 0.45	1.49 ± 0.42	0.839
Multiplicity (%)	73.53	68.09	0.492
Skin involvement (%)	3.92	6.38	0.679
Tenderness (%)	3.92	0.00	0.308
Firm (%)	73.53	72.34	0.879
Nonmobile (%)	65.69	57.45	0.333
Pulsatile (%)	0.00	0.00	1.000

F = female, L/S = long to short, L = left, M = male, OB = open biopsy, R = right, USCB = ultrasound-guided core biopsy.

TABLE 4. Diagnostic Accuracy of Ultrasound-Guided Core Biopsy and Open Biopsy in Sampling Supraclavicular Fossa Tumors

	Accuracy	Inadequate Specimen	Atypical Lymphoid Infiltrate
USCB	90.2% (92/102) (confirmed diagnosis: 84; atypical lymphoid infiltrates in both USCB and OB: 8)	5.9% (6/102)	11.8% (12/102) (atypical lymphoid infiltrates in both USCB and OB: 8; lymphoma in OB: 3; Kikuchi disease in OB: 1)
OB	93.6% (44/47)	0% (0/47)	6.4% (3/47)
P-value	>0.05	>0.05	>0.05

OB = open biopsy, USCB = ultrasound-guided core biopsy.

TABLE 5. The Effect of Tumor Factors on the Accuracy of Confirming Pathological Diagnoses of Initial Sampling by Ultrasound-Guided Core Biopsy and Open Biopsy

	USCB *P*-Value	CI (95%)	OB *P*-Value	CI (95%)
Long axis	0.994	0.584–1.719	0.668	0.389–1.831
Short axis	0.697	0.476–1.643	0.899	0.331–3.517
L/S axis ratio	0.085	0.715–176.418	0.318	0.039–2.869
Multiplicity	0.370	0.085–2.502	0.957	0.089–12.831
Firm	0.188	0.489–38.126	0.821	0.062–9.050
Nonmobile	0.854	0.276–4.740	0.401	0.029–4.111

CI = confidence interval, L/S = long to short, OB = open biopsy, USCB = ultrasound-guided core biopsy.

TABLE 6. Clinical Factors of Sampling Supraclavicular Fossa Tumors Using Ultrasound-Guided Core Biopsy and Open Biopsy

|	Time (<10 min)	Incision Length (>1 cm)	Hospitalization	Anesthesia
USCB	100%	0%	No	Local
OB	0%	100%	Yes[*]	Local or general[*]
P-value	<0.05	<0.05		

OB = open biopsy, USCB = ultrasound-guided core biopsy.
[*] For deep-seated SC tumor.

pathological reports showed metastatic carcinoma with negative results of Epstein–Barr virus in situ hybridization. It thus revealed the potential of distinct metastatic origin rather than original nasopharyngeal carcinoma. The patient was finally diagnosed as lung cancer with SC lymph node metastasis. The patient was then directly scheduled for specific treatment of lung cancer instead of spending effort in arranging OB and postoperative wound care. It showed benefits of employing USCB as the first-line approach to diagnose SC tumors.

USCB is competent to diagnose lymphoma. It has been a long-term debate that minimally invasive procedures are inadequate for lymphoma diagnosis.[19] However, previous studies mainly focused on FNA. It has been changed when USCB is applied as another sampling procedure with minimal invasiveness.[20,21] Even applied in the head and neck, specimens harvested from USCB are sufficient to make the final diagnosis of lymphoma. Noticeably, immunohistochemical staining, an essential procedure to subgroup lymphoma, is doable in USCB specimens. In our series, different types of lymphoma were

exclusively confirmed by USCB. This application further strengthens the capacity of USCB in sampling SC tumors. Lymphoma is mainly treated by medical treatments without any need of surgical intervention. It is therefore the sampling procedure with minimal invasiveness is promising. Diagnosed by USCB, patients with lymphoma can be scheduled immediately for staging and treatments.

Another useful application of USCB in diagnosing SC tumors is to confirm the possibility of extrapulmonary tuberculosis. It is an infectious disease and basically managed by medical treatments. The feasibility of employing USCB in diagnosing extrapulmonary tuberculosis has been demonstrated previously.[22,23] In the current series, granulomatous inflammation has the highest incidence in the category of benign diseases. Because extrapulmonary tuberculosis is difficult to be diagnosed by FNA, microbiological staining, tissue culture, pathological presentations of granulomatous inflammation identified in USCB specimens facilitate the diagnoses.[24–26] In addition, severe local inflammation of extrapulmonary
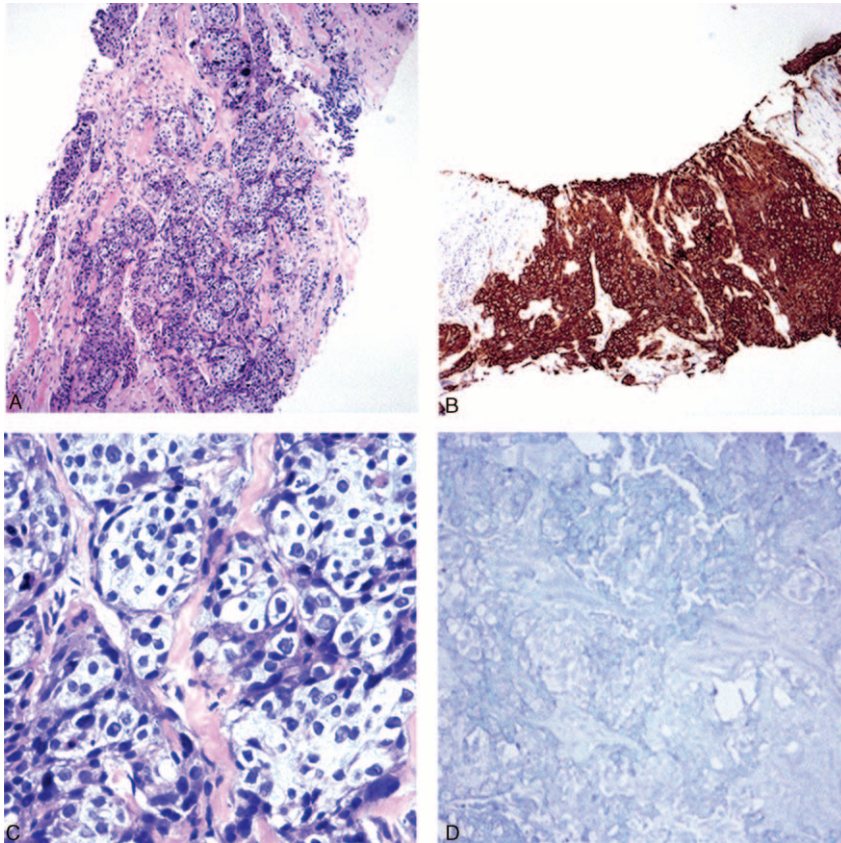
FIGURE 6. The pathological presentations of a SC tumor harvested by USCB. A 62-year-old male with treated NPC presented with a left SC tumor and was diagnosed as lung cancer metastasis by USCB. (A) HE staining of the specimens harvested from the SC tumor by USCB, 100×. (B) Immunostaining with cytokeratin showed strongly positive responses, 100×. (C) A high power view with HE staining demonstrated that soft tissue was infiltrated by nested cells. These cells had increased nuclear-cytoplasmic ratio and pleomorphism. Focal clear changes of cells characterized by clear cytoplasm were noticed, 400×. (D) Epstein–Barr virus in situ hybridization was negative, 400×.
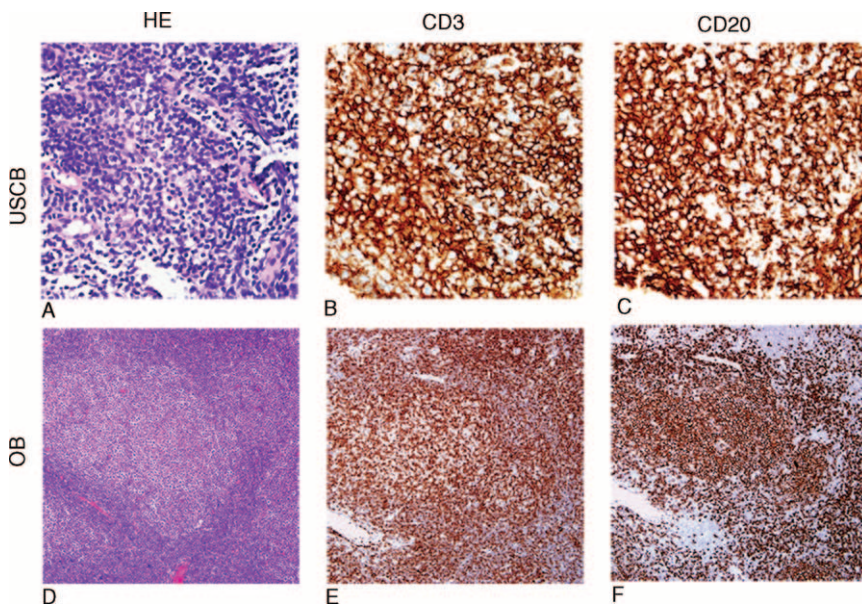
FIGURE 7. Comparison of the pathological presentations of specimens harvested form SC tumors by USCB and OB. A case diagnosed as lymphoma presenting with SC tumors. The pathological figures including HE and immunohistochemical staining in the upper panel are based on the specimens harvested from USCB, whereas those in the lower panel are from the specimens harvested by OB. (A) HE, 400×. (B) CD3, 400×. (C) CD20, 400×. (D) HE, 100×. (E) CD3, 100×. (F) CD20, 100×.

tuberculosis easily obscures the junction between infectious foci and abutting vessels and nerves, which increase operative risks. USCB can avoid difficult surgical situations, poor wound healing, and obvious postoperative scars.

Neurogenic tumors are frequently found in SC areas because of underlying nervous networks. USCB can detect neurogenic tumors in advance to prevent unnecessary operations and associated complications. Because ultrasound is a real-time imaging technique, the SC tumor is easily traced along the nerve bundle. Typical features of neurogenic tumors are clearly clarified by sonographic imaging. The sampling site of neurogenic tumor is cautiously identified during the procedure of USCB to prevent potential nerve injury. No complications were found in the patients diagnosed as neurogenic tumors in our study. USCB is accordingly superior to OB because of reducing the incidence of procedure-related complications.

Several cases of SC tumors were not successfully diagnosed by USCB in our series. Failure of confirming pathological diagnoses also happened in some cases of the first trial of OB sampling. It demonstrated that the possibility of sampling errors could happen either in USCB or OB, depending on which part of tumor was taken for diagnosis. Another possibility of failed USCB may due to tumor features such as having multiple cystic components. It may reduce the chance of harvesting solid parts of tumor by USCB for pathological examination. Another 6 cases diagnosed as atypical lymphoid infiltrates by USCB were confirmed by OB for final diagnoses. Specimens of USCB shown in some cases had similar features as those finally presented by OB (Figure 7). It is therefore the accuracy and diagnostic rates are highly dependent on experienced pathologists who can identify the typical tumor characteristics presenting in USCB specimens. Multiple shots of USCB sampling may compensate sampling errors, a common drawback of small specimens harvested by minimally invasive techniques. There was also 1 case presenting a tumor exactly located beneath the clavicle, a bony structure that completely obscured the sonographic window for introducing appropriate sampling route of the core needle. These cases demonstrates some limitations when USCB is used to diagnose SC tumors. Since ultrasound-guided technique is dependent on experience and skillful expertise, USCB performed by, or supervised by experienced operators is suggested to assure safety and improve the diagnostic accuracy.

In conclusion, USCB is competent to diagnose SC tumors with comparable accuracy and preciseness. Under real-time monitoring by ultrasound, SC tumors are easily identified and sampled. Without surgical procedures and wound care, USCB is time and cost saving. Among numerous differential diagnoses of SC tumors, specimens harvested from USCB can be processed by standard pathological examinations including immunohistochemical staining to facilitate diagnoses and subtype characterization. USCB is therefore suggested to be included as the first-line diagnostic tool for SC tumors.

ACKNOWLEDGMENTS

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