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● *Original Contribution*

HIGH-RESOLUTION ULTRASOUND OF SCHWANNOMAS OF THE LIMBS: ANALYSIS OF 72 CASES

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Abstract—Schwannomas are common benign tumors that develop in peripheral nerves. High-resolution ultrasound (HRUS) is an effective imaging modality in clinics. The aim of this study was to define the value of HRUS in diagnosing schwannomas that originate from different nerves in limbs. We reviewed the ultrasound and surgical records of 72 pathologically confirmed schwannomas in the limbs of 60 patients. Results revealed that 44 (61.1%) of 72 cases, 44 (75.9%) of 58 cases and 0 (0%) of 14 cases received an overall correct pre-operative diagnosis, a correct pre-operative diagnosis in nerve trunks and a correct pre-operative diagnosis in small branches, respectively. Identification of the nerve of origin of schwannomas through HRUS likely increased confidence in diagnosing these benign tumors. (E-mail: y_wang1111@hotmail.com) **© 2016 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Schwannoma, Ultrasound, Limb.**

INTRODUCTION

Schwannomas are benign peripheral nerve tumors originating from Schwann cells in the nerve sheath. The incidence of schwannomas in Eastern countries is 5% in adults and 2% in children (Forthman and Blazar 2004). In the extremities, a schwannoma may arise from any of the peripheral nerves, and it can be asymptomatic for a long period (Holdsworth 1985). The majority of patients are admitted to outpatient clinics because of a slow-growing mass that causes symptoms of compression in surrounding tissues and tingling sensations in the distribution of the involved nerve (Kang et al. 2000). A schwannoma can be managed with multiple treatment options, including observation, complete tumor excision and intra-capsular enucleation (Adani et al. 2014). An accurate pre-operative diagnosis, preferably with identification of the nerve of origin, is crucial to schwannoma management because of the substantial chance of nerve palsy post-surgery (Oberle et al. 1997; Sawada et al. 2006).

With advances in ultrasound technology, high spatial resolution has been achieved. For instance, high-resolution ultrasound (HRUS) can define the size, shape, vascularity and origin of a schwannoma; thus, this technology helps surgeons plan surgery (Adani et al. 2014; Ozdemir et al. 2005). On sonography, a schwannoma appears as an oval, well-defined, hypo-echoic and homogeneous mass (sometimes with an inner anechoic area) directly connected to a cord-like echogenic structure (Fornage 1988; Lin and Martel 2001; Ryu et al. 2015; Simonovsky 1997). Nerve identification is essential because it is pathognomonic of a peripheral nerve sheath tumor (Beaman et al. 2004; Stull et al. 1991; Suh et al. 1992).

In our clinical practice, radiologists can confidently identify nearly all of the nerve trunks running in the limbs. They have encountered many cases of schwannomas that are empirically distinguishable on the basis of sonographic findings. This study aimed to define the value of HRUS in diagnosing schwannoma that originated from different nerves in the limbs.

METHODS

We reviewed the ultrasound and surgical records of 72 pathologically diagnosed schwannomas in the limbs of 60 patients admitted to the Department of Hand and Foot Surgery at Fudan University Huashan Hospital between July 2014 and December 2015. The experimental

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Table 1. Characteristics of schwannomas

Characteristic	Number
Size	
≤3 cm	13
>3 cm	59
Shape	
Round	3
Oval	64
Regular	5
Border	
Well defined	70
Ill-defined	2
Inner echo	
Hypo-echoic homogeneous	61
Inner anechoic	11
Vascularity	
Rich	6
Poor	66

protocol was approved by the local institutional review board. Informed consent for the study was obtained from all patients in accordance with the Ethical Principles for Medical Research Involving Human Patients established in the World Medical Association Declaration of Helsinki.

Ultrasound images were obtained using a Preirus scanner (Hitachi Medical, Tokyo, Japan) equipped with a EUP-L53 linear transducer and an iU22 scanner (Philips Bothell, WA, USA) equipped with a L17-5 linear transducer. HRUS was independently performed by five board-certified radiologists with 5–10 y of experience in musculoskeletal ultrasonography. The patients were assigned to five different radiologists on the basis of the hospital diagnosis queuing system.

The cords of the brachial plexus, the medial cutaneous nerve of the forearm and the median, ulnar, radial, femoral, tibial and peroneal nerves can be easily detected with HRUS. These nerves are collectively defined as the nerve trunk. Conversely, digital, saphenous and cutaneous nerves, which are defined as small nerve branches, cannot be easily detected with HRUS. The location, size, shape, internal echo texture and origin of a schwannoma were noted when we reviewed the ultrasound reports. A failed diagnosis of schwannoma was considered a report that indicated only a solid or hybrid mass without a certain diagnosis or a report that did not mention the nerve from which the schwannoma originated.

Table 2. Nerves from which schwannomas originated

Nerve	Diameter (mm)	Number	Failed diagnosis	Structural loss of involved nerve
Ulnar	5–100 (23.9 ± 20.9)	19	3	6
Median	10–60 (26.2 ± 14.8)	18	5	2
Radial	10–44 (20.1 ± 13.4)	12	4	
Digital	2–40 (16.0 ± 13.3)	8	8	1
Cutaneous	6–22 (12.2 ± 6.4)	5	5	
Tibial	15–32 (26.3 ± 7.8)	4	1	2
Peroneal nerve	7-24 (17.3 ± 9.1)	3	1	
Cords of brachial plexus (medial)	77	1	0	
Medial cutaneous of forearm	38	1	0	
Saphenous	23	1	1	
Total	2–100 (21.9.6 ± 15.6)	72	28	

Surgery was performed at the Department of Hand and Foot Surgery at Fudan University Huashan Hospital. The anatomic location, size, shape and origin of the schwannoma and whether this schwannoma was completely enucleated were noted when we reviewed the surgical records.

The χ^2 test was conducted to analyze categorical variables. Statistical significance was set at $p < 0.05$. Statistical analyses were performed in SPSS Version 22.0 for Windows (IBM, Armonk, NY, USA).

RESULTS

A total of 60 patients, including 25 women and 35 men, with 72 pathologically proven schwannomas of the extremities were included in this study. Patient age ranged from 12 to 85 y (mean age: 50.1 ± 17.8 y). Their medical history ranged from 1 mo to 30 y.

All patients presented with palpable soft tissue masses. Local tenderness occurred in 19 (31.7%) patients, whereas tingling occurred in 24 (40%) patients when percussed (Tinel's sign). A total of 14 (23.3%) patients complained of a mass growing in a relatively short time, whereas 3 (5%) patients complained of neurologic dysfunction.

Table 3. Parts of limbs in which schwannomas were located

Location	Diameter (mm)	Number	Failed diagnosis	Structural loss of involved nerve
Armpit	77	1	0	
Upper arm	10–100 (27.1 ± 23.0)	17	6	1
Elbow	15–31 (22.0 ± 8.2)	3	1	1
Forearm	5–60 (21.1 ± 13.3)	20	4	1
Wrist	14–32 (19.8 ± 7.2)	5	1	2
Palm	5–60 (24.8 ± 15.1)	13	6	5
Fingers	5–22 (8.4 ± 7.9)	5	5	
Popliteal space	15	1	0	
Shank	7–27 (18.3 ± 10.3)	3	2	1
Foot	24–32 (28 ± 5.7)	2	1	
Thigh	6–23 (14.5 ± 12.0)	2	2	
Total	2–100 (21.9.6 ± 15.6)	72	28	