Sonographic Features of Soft Tissue Tumors in the Hand and Forearm

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Background: High-resolution sonography is well suited for screening soft tissue masses because of its safety, low cost, and real-time, dynamic imaging. The purpose of our study was to elaborate the preoperative sonographic features of soft tissue tumors of the hand and forearm and the corresponding histologic results.

Methods: Thirty-one soft tissue tumors of the hand and forearm were evaluated by ultrasound preoperatively. The mobility, consistency, echogenicity, margin, and color Doppler signal of each tumor were assessed. Dynamic study was also performed. The pathologic diagnosis was obtained after subsequent surgery.

Results: The pathologic diagnoses of these soft tissue lesions were lipoma (n = 6), ganglion cyst (n = 6), neurilemmoma (n = 3), neurofibroma (n = 3), giant cell tumor (n = 10), tenosynovitis (n = 2), and malignant lymphoma (n = 1). An adjacent tendon or communication duct extending to the joint space could be found in most giant cell tumors and ganglion cysts; a traceable nerve could be found in most nerve sheath tumors. All benign tumors appeared well-defined. The only malignant tumor appeared ill-defined without a color Doppler signal.

Conclusion: Sonography enables a reliable diagnosis of the cystic or solid nature of soft-tissue lesions, accurate estimation of the volume, and precise three-dimensional localization of the abnormality. Examiners should perform a dynamic examination and trace the adjacent structure to obtain more diagnostic clues.
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Key words: sonography, soft tissue tumor, ultrasound, hand and forearm

Soft tissue tumors are frequently encountered in clinical practice. The incidence of malignant soft tissue tumors is approximately 1-1.4 new cases per 100,000 population whereas the incidence of benign soft tissue neoplasms is estimated to be at least 100 times more common.[1]

Preoperative evaluation of soft tissue tumors often requires sophisticated imaging studies followed by biopsy.[2] The role of imaging is essential either to confirm the benign or malignant nature of the mass or to give information for a diagnostic biopsy. Plain radiographs are sensitive for soft tissue calcification

and ossification which can assist with characterization. However, they have little ability to detect or evaluate most soft-tissue lesions in the extremities, and other imaging techniques are required.[3] Ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), scintigraphy with tumor or bone seeking agents,[4] and positron emission tomography[5] are modalities currently available to evaluate soft tissue tumors. Among these techniques, ultrasound seems well suited for screening soft tissue masses because of its safety, low cost, and apparent sensitivity. It can also uniquely provide dynamic examination. Use of sonography enables a reliable diagnosis of the cystic or solid nature of soft-tissue lesions, accurate estimation of the volume, and precise three-dimensional localization of the abnormality.[6]

However, caution is needed in making a specific diagnosis in solid masses by ultrasound. Höglund[7] found an accuracy of 56% in the ultrasound diagnosis of soft tissue tumors in the forearm and hand. Beggs[8] concluded that solid tumours may have specific appearances on ultrasound, but biopsy is often required.

The purpose of our study was to elaborate the preoperative sonographic features of soft tissue tumors in the hand and forearm and the corresponding pathologic results, and to see whether preoperative sonography could provide surgeons with additional information.

METHODS

For about one year we retrospectively collected 31 soft tissue tumors in the hand or forearm of 28 patients (11 men, 17 women, ages 22-72 years) who had received ultrasound evaluation and subsequent surgical excision of the tumor. Preoperative sonographic examinations were done with a commercially available machine (LOGIQ 700 MR, General Electronic Company, Milwaukee, WI, USA), using a 7.5 MHz linear-array real-time transducer. Examinations included evaluations of the lesions while the hands were at rest and during flexion and extension of the involved segments. Scanning was done in both the transverse and longitudinal planes. The mobility, consistency, echogenicity (hypoechoic, isoechoic, or hyperechoic relative to muscle),[9] and margin of the tumors were assessed, and the greatest

length, width, and depth of each tumor were measured. In addition, all tumors were examined with color Doppler imaging to determine whether blood vessels could be demonstrated around or inside the tumor.

A pathologic diagnosis was obtained after subsequent surgical removal of each tumor.

RESULTS

The pathologic diagnoses of these soft tissue lesions were lipoma (n = 6), ganglion cyst (n = 6), neurilemmoma (n = 3), neurofibroma (n = 3), giant cell tumor (n = 10), tenosynovitis (n = 2), and malignant lymphoma (n = 1). The sonographic features of these tumors are summarized in the Table 1.

1. Lipomas. All six lipomas were well-defined solid tumors (Fig. 1). Five were hyperechoic, and the other was isoechoic relative to the adjacent muscle. There was no posterior enhancement or color Doppler signal in these lipomas.

2. Ganglion cysts. These six ganglion cysts were all well-defined anechoic cystic lesions without internal color Doppler signals on sonography. Four had a traceable tendon, and the other two had a communication duct extending to the articular space (Fig. 2). Posterior enhancement was observed in four of these cysts.

3. Nerve sheath tumors. There were three neurilemmomas and three neurofibromas. All were well-defined, heterogenic hypoechoic solid masses sonographically (Fig. 3). Five of these masses had a traceable nerve [ulnar nerve (n = 2) and median nerve (n = 3)]. Posterior enhancement was noted in three masses. A color Doppler signal was absent in all these tumors.

4. Giant cell tumors. All ten giant cell tumors were well-defined hypoechoic solid masses without a color Doppler signal on sonography (Fig. 4). Seven were adjacent to a traceable tendon. Posterior enhancement was noted in five tumors.

5. Tenosynovitis. Only two tumors were diagnosed as tenosynovitis pathologically. Both had well-defined margins and target signs on sonography (Fig. 5). A color Doppler signal was noted in one lesion (Fig. 6).

6. Malignant lymphoma. One tumor was diagnosed as malignant lymphoma by pathology. It appeared as an ill-defined hypoechoic solid mass

Table 1. Sonographic Features of 31 Soft Tissue Tumors

Pathologic diagnosis	Lipoma (n = 6)	Ganglion cyst (n = 6)	Nerve sheath tumor (n = 6)	Giant cell tumor (n = 10)	Tenosynovitis (n = 2)	Malignant lymphoma (n = 1)
Location	Finger (1) Hand (3) Forearm (2)	Wrist (4) Finger (2)	Finger (1) Wrist (1) Forearm (3) Elbow (1)	Finger (8) Hand (2)	Finger (1) Wrist (1)	Forearm
Margin	Well-defined (6)	Well-defined (6)	Well-defined (6)	Well-defined (10)	Well-defined (2)	Ill-defined
Echogenicity	Hyperechoic (5) Isoechoic (1)	Anechoic (6)	Heterogenic hypoechoic (6)	Hypoechoic (10)	Target sign (2)	Hypoechoic
Posterior enhancement	(0)	(4)	(3)	(5)	(0)	-
Color doppler	Absent (6)	Absent (6)	Absent (6)	Absent (10)	Present (1) Absent (1)	Absent
Other features		Traceable tendon (4) Communication duct extending to articular space (2)	Traceable nerve (5): Ulnar (2) Median (3) Pathologic diagnosis: Neurilemmoma (3) Neurofibroma (3)	Adjacent to tendon (7)		

without posterior enhancement on sonography (Fig. 7). A color Doppler signal was absent.

DISCUSSION

Through dynamic ultrasound examination of the movement of the adjacent body segment and tracing the adjacent structure of the tumor with color Doppler imaging, ultrasound can provide valuable information before surgery or biopsy, even though it is usually difficult to diagnose a soft tissue tumor using ultrasound only.

Lipomas were believed to be elongated masses with their greatest diameter parallel to the skin, with variable echogenicity.[10] In our study, lipomas seemed to share almost the same sonographic features. They were well-defined, solid hyperechoic (except for one isoechoic lipoma) lesions without a color Doppler signal.

All ganglions in our study were well-defined, anechoic cystic lesions on sonogram. Either a traceable tendon or a communication duct extending to the joint space could be found in all cases. These traceable structures could provide clues for accurate diagnosis. In Hoglund et al's study, non-palpable ganglions causing clinical symptoms could also be demonstrated on ultrasound, and sonography could delineate the entire ganglion and often its connection
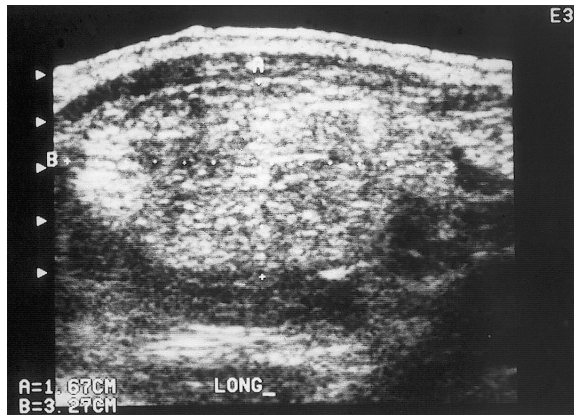
Fig. 1 Lipoma. Sonogram shows a well-defined, hyperechoic solid mass in the subcutaneous layer without a color Doppler signal. The tumor was compressible during dynamic study.
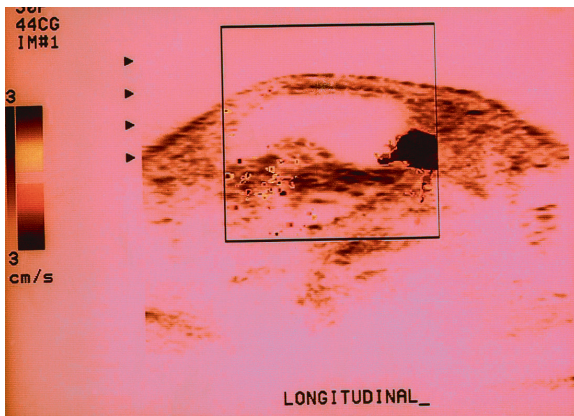

Fig. 2 Ganglion cyst. Sonogram shows a well-defined, anechoic cystic lesion with a communication duct extending to the joint space.
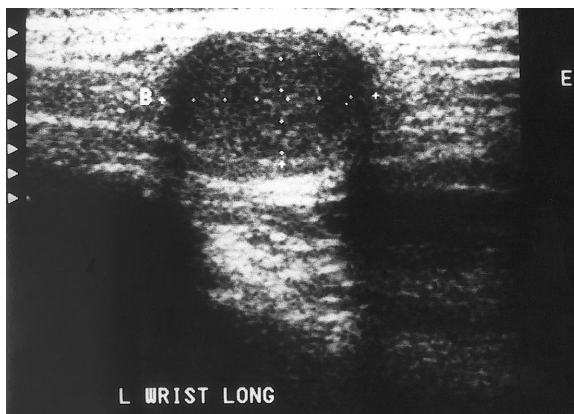

Fig. 3 Nerve sheath tumor. Sonogram of the left wrist shows a well-defined, heterogenic, hypoechoic solid mass with a traceable nerve. Posterior enhancement was noted.
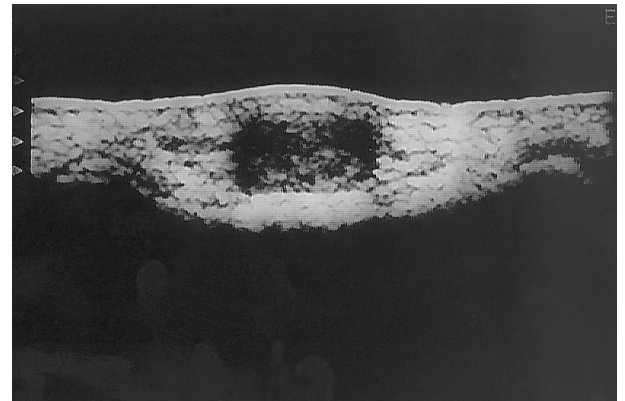

Fig. 4 Giant cell tumor. Sonogram shows a well-defined, hypoechoic solid mass with a traceable tendon.
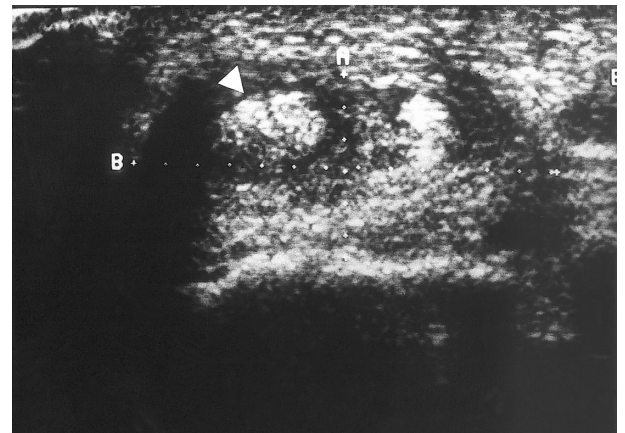

Fig. 5 Tenosynovitis. The target sign (anechoic halo around the tendon in the transverse image) is shown in the sonogram. The hyperechoic structure (arrowhead) within the 'target' is a tendon.
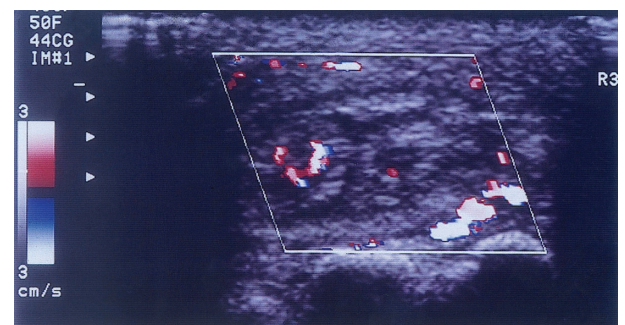

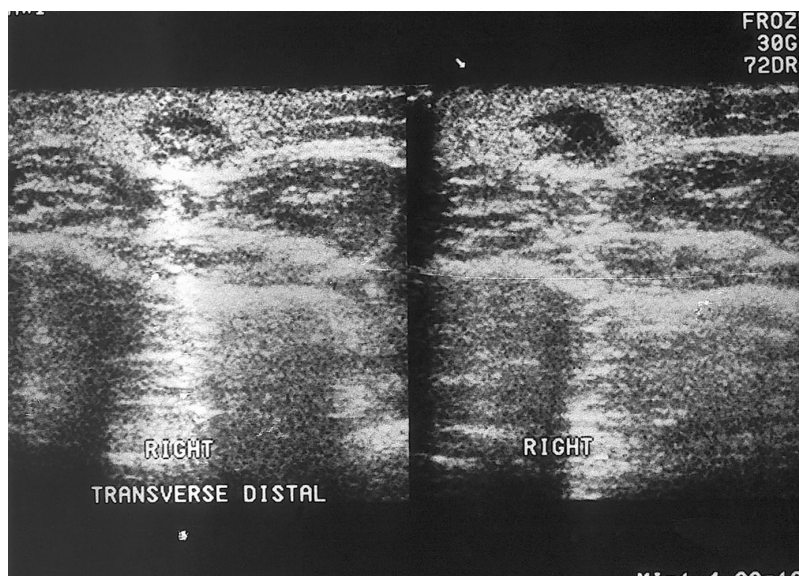**Fig. 6** A color Doppler signal in a case of tenosynovitis.

Fig. 7 Lymphoma. Sonogram shows an ill-defined, hypoechoic mass without a color Doppler signal in the subcutaneous layer. The lymphoma infiltration is within the subcutaneous fat with surrounding increased echogenicity.

with the joint space.[11]

Nerve sheath tumors are often hypoechoic solid masses, and the presence of intrinsic blood flow on color Doppler sonography and peripheral nerve continuity suggests the diagnosis.[12] In our study, a traceable nerve could be found in five of the six nerve sheath tumors. But none of these tumors had detectable intrinsic blood flow on color Doppler images. Nevertheless, a traceable nerve could confirm the tissue origin of the tumor and provide hints for diagnosis. However, there is considerable overlap between the sonographic appearances of neurofibromas and neurilemmomas,[10] and sonography cannot reliably distinguish between them.[12]

In both cases of tenosynovitis in our study, a target sign-defined as an anechoic halo around the tendon on transverse images-was found. A color Doppler signal was present in one case. Breidahl et al found a positive correlation between the power Doppler sonographic grade and the percentage of the peritendinous hypoechoic rim that had flow,[13] and suggested that a significant proportion of the hypoechoic rim probably represents vascularized synovium rather than complex fluid.

Giant cell tumors are a circumscribed form of tenosynovitis related to pigmented villonodular syn-

ovitis.[10] They typically appear as solid, homogeneous, hypoechoic masses with detectable internal vascularity and are associated with the flexor tendons of the fingers.[14] Seven of ten giant cell tumors in our study were adjacent to the tendon sheath. However, none of them had detectable internal vascularity on color Doppler images.

Only one tumor in our study, a subcutaneous lymphoma, was malignant. It was an ill-defined hypoechoic mass without detectable intrinsic blood flow sonographically. The differential diagnosis between lymphoma and lymphadenitis is frequently impossible on the basis of sonographic and color Doppler patterns alone.[15] In a retrospective study, the sonographic appearance of lymphoma varied, and included masses, nodal or confluent nodes, small disseminated nodules, the myositis type, and even a panniculitis type.[16]

In our study, all benign tumors appeared well-defined, and the only malignant tumor appeared ill-defined. However in Lange et al's study, sonograms of all fourteen malignant lesions showed a discrete pattern, while sonograms of the benign tumors showed twenty-one discrete and fifteen ill defined patterns.[17] Thus, whether the margin of soft tissue tumors on sonograms can predict tumor malignancy

is still under debate.

Although malignant tumors are by their nature vascular, a minority of malignant tumors have no demonstrable vessels on color Doppler imaging, even on the most sensitive settings.[18,19] Griffith et al concluded that if an organized (instead of chaotic) vascular pattern is present, the tumor is more likely to be benign.[20]

Although it is not easy to differentiate benign from malignant soft tissue tumors on ultrasound, the accuracy of MR imaging in the majority of soft-tissue masses is also insufficient, and most masses require a biopsy to confirm the diagnosis.[21] Ultrasound can be used to guide percutaneous aspiration cytology or needle biopsy of soft-tissue tumors.[22] When soft tissue tumors exhibit their typical benign and diagnostic imaging features, a biopsy is not necessary (e.g. ganglion cysts, nerve sheath tumors, lipomas, and tenosynovitis). On the other hand, when a solid large soft tissue tumor is encountered and malignancy cannot be excluded, an echo-guided cutting needle biopsy may be helpful in treatment planning.[23,24] Ultrasound is also often selected for follow-up study of soft tissue tumors because of its convenience, ease of operation, availability, and accuracy in detecting a soft-tissue tumor.[3,25]

There were some drawbacks in our study. First, no intrinsic blood flow was detected by color Doppler in any nerve sheath tumor or giant cell tumor, which seems inconsistent with the known facts. Compared with color Doppler, power Doppler is much more sensitive to slow flow and usually proves to be more valuable.[26] Thus, power Doppler, which was not used in our study, may have the potential to display tissue perfusion in malignant tumors. Moreover, the case number in our study was insufficient, with only one malignant tumor included.

CONCLUSION

High-resolution sonography is a cost-effective screening tool for soft tissue tumors in the hand and forearm. It enables a reliable diagnosis of the cystic or solid nature of soft-tissue lesions, accurate estimation of the volume, and precise three-dimensional localization of the abnormality. It also can provide information on the vascularity of a soft-tissue tumor preoperatively. Examiners should perform a dynamic examination and trace the adjacent structure of the tumor (e.g. nerve, tendon, or joint space) to obtain more diagnostic clues.

REFERENCES

1. Rydholm A, Berg NO, Gullberg B, Thorngren KG, Persson BM. Epidemiology of soft tissue sarcoma in the locomotor system: a retrospective population-based study of the interrelationships between clinical and morphological variables. APMIS 1984;92A:375-86.
2. Gibbs CP, Peabody TD, Simon MA. Classification, clinical features, preoperative assessment and staging of soft tissue tumors. Curr Orthopaed 1997;11:75-82.
3. Johnstone AJ, Beggs I. Ultrasound imaging of soft-tissue masses in the extremities. J Bone Joint Surg Br 1994;76B:688-9.
4. Gilbert TJ Jr, Thompson RC Jr. Imaging of soft tissue tumors. Curr Orthopaed 1997;11:83-97.
5. Griffeth LK, Dehdashti F, McGuire AH, McGuire DJ, Perry DJ, Moerlein SM, Barry A Siegel. PET evaluation of soft-tissue masses with fluorine-18 fluoro-2-deoxy-D-glucose. Radiology 1992;182:185-94.
6. Fornage BD, Schernberg FL, Rifkin MD. Ultrasound examination of the hand. Radiology 1985;155:785-8.
7. Höglund M. Ultrasound diagnosis of soft-tissue tumours in the hand and forearm. A prospective study. Acta Radiol 1997;38:508-13.
8. Beggs I. Ultrasound of soft tissue masses. Imaging 2002;14:202-8.
9. Inampudi P, Jacobson JA, Fessell DP, Carlos RC, Patel SV, Delaney-Sathy LO, van Holsbeeck MT. Soft-tissue lipomas: accuracy of sonography in diagnosis with pathologic correlation. Radiology 2004;233:763-7.
10. Fornage BD. Soft-tissue masses. In: Fornage BD, ed. Musculoskeletal Ultrasound. 1st ed. New York: Churchill Livingstone, 1995:21-42.
11. Höglund M, Tordai P, Muren C. Diagnosis of ganglions in the hand and wrist by sonography. Acta Radiol 1994;35:35-9.
12. Reynolds DL Jr, Jacobson JA, Inampudi P, Jamadar DA, Ebrahim FS, Hayes CW. Sonographic characteristics of peripheral nerve sheath tumors. AJR Am J Roentgenol 2004;182:741-4.
13. Breidahl WH, Stafford Johnson DB, Newman JS, Adler RS. Power Doppler sonography in tenosynovitis: significance of the peritendinous hypoechoic rim. J Ultrasound Med 1998;17:103-7.
14. Middleton WD, Patel V, Teefey SA, Boyer MI. Giant cell tumors of the tendon sheath: analysis of sonographic findings. AJR Am J Roentgenol 2004;183:337-9.
15. Giovagnorio F, Galluzzo M, Andreoli C, De CM, David V. Color Doppler sonography in the evaluation of superficial lymphomatous lymph nodes. J Ultrasound Med 2002;21:403-8.
16. Chiou HJ, Chou YH, Chiou SY, Chen WM, Chen W,

Wang HK, Chang CY. High-resolution ultrasonography of primary peripheral soft tissue lymphoma. J Ultrasound Med 2005;24:77-86.

17. Lange TA, Austin CW, Seibert JJ, Angtuaco TL, Yandow DR. Ultrasound imaging as a screening study for malignant soft-tissue tumors. J Bone Joint Surg Am 1987;69:100-5.

18. Lagalla R, Iovane A, Caruso G, Lo Bello M, Derchi LE. Color Doppler ultrasonography of soft-tissue masses. Acta Radiol 1998;39:421-6.

19. Giovagnorio F, Andreoli C, De Cicco ML. Color Doppler sonography of focal lesions of the skin and subcutaneous tissue. J Ultrasound Med 1999;18:89-93.

20. Griffith JF, Chan DPN, Kumta SM, Chow LTC, Ahuja AT. Does Doppler analysis of musculoskeletal soft-tissue tumours help predict tumour malignancy? Clin Radiol 2004;59:369-75.

21. Crim JR, Seeger LL, Yao L, Chandnani V, Eckardt JJ. Diagnosis of soft-tissue masses with MR imaging: can benign masses be differentiated from malignant ones? Radiology 1992;185:581-6.

22. Zornoza J, Bernardino ME, Ordonez NG, Thomas JL, Cohen MA. Percutaneous needle biopsy of soft tissue tumors guided by ultrasound and computed tomography. Skeletal Radiol 1982;9:33-6.

23. Liu JC, Chiou HJ, Chen WM, Chou YH, Chen TH, Chen W, Yen CC, Chiu SY, Chang CY. Sonographically guided core needle biopsy of soft tissue neoplasms. J Clin Ultrasound 2004;32:294-8.

24. Soudack M, Nachtigal A, Vladovski E, Brook O, Gaitini D. Sonographically guided percutaneous needle biopsy of soft tissue masses with histopathologic correlation. J Ultrasound Med 2006;25:1271-7.

25. Hsu TC, Tang FT, Wang CL, Chen HC. High-resolution ultrasonography in detection and follow-up of a tumour of the forearm. Scand J Plast Reconstr Surg Hand Surg 1999;33:125-7.

26. Van Holsbeeck M, Introcaso JH. Physical principles of ultrasound imaging. In: Van Holsbeeck M, Introcaso JH, eds. Musculoskeletal Ultrasound. 2nd ed. St. Louis: Mosby, 2001:1-7.

上肢軟組織腫瘤的超音波特徵

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背 景： 軟組織超音波因其安全、價格低廉及可做動態即時檢查而適用於軟組織腫瘤的篩檢。本研究的目的在闡述上肢軟組織腫瘤的術前超音波特徵，及對應的組織學結果。

方 法： 以超音波分別評估三十一個軟組織腫瘤的移動性、一致性、超音波回音、邊緣，及彩色都普勒 (color Doppler) 信號。隨後進行手術切除腫瘤，而得到病理診斷。

結 果： 三十一個腫瘤的病理診斷分別爲：脂肪瘤 (lipoma) (n = 6)、腱鞘囊腫 (ganglion cyst) (n = 6)、神經鞘瘤 (neurilemmoma) (n = 3)、神經纖維瘤 (neurofibroma) (n = 3)、巨細胞瘤 (giant cell tumor) (n = 10)、腱鞘炎 (tenosynovitis) (n = 2)，及惡性淋巴瘤 (malignant lymphoma) (n = 1)。在大部分的巨細胞瘤及腱鞘囊腫中，可發現相鄰的肌腱或相通的關節腔；而在大部分的神經鞘瘤 (nerve sheath tumor) 中可找到起源的神經。所有的良性瘤都是邊緣清楚的。唯一的惡性瘤邊緣不清楚，其中也沒有彩色都普勒 (color Doppler) 信號。

結 論： 超音波可提供區分囊狀或實心軟組織腫瘤的可靠診斷，亦可在術前正確估計軟組織腫瘤的體積及三度空間定位。檢查者應詳加尋找鄰近可追溯的構造 (例如：肌腱、神經或關節腔) 以提供診斷線索。
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關鍵詞： 軟組織腫瘤，超音波，上肢