Elastographic and contrast-enhanced ultrasound features of a benign schwannoma of the common fibular nerve

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Abstract Differential diagnosis of a mass in the popliteal fossa includes a number of pathologies, such as Baker's cyst, extra-articular ganglia cyst, hematoma, proliferation of adipose tissue, aneurysm of the popliteal artery, thrombosed varicose vein, gouty tophi and benign or malignant soft tissue tumors. Schwannoma is the most common benign peripheral nerve tumor. However, only a few authors have so far reported on schwannomas located on the common fibular nerve. The aim of this paper is to present contrast-enhanced ultrasound and ultrasound elastographic features of a rare case of schwannoma of the common fibular nerve as well as imaging features of a schwannoma of the peripheral nerve.

Keywords Contrast-enhanced ultrasonography · US-elastography · Peripheral nerve schwannoma

Riassunto La diagnosi differenziale delle masse poplitee include: la cisti di Baker, cisti gangliari extraarticolari, proliferazione del tessuto adiposo, aneurismi poplitei, vene trombizzate, tofi gottosi o tumori maligni o benigni. Lo Schwannoma è il più frequente tumore dei nervi periferici. Comunque, ad oggi, soltanto pochi casi riguardo agli Schwannomi del nervo comune peroneale sono stati descritti. Nel presente lavoro vengono revisionati gli aspetti ecocontrastografici e elastosonografici di un raro caso di

Schwannoma del nervo peroneale comune e gli aspetti ecografici dello Schwannoma periferico.

Introduction

Lesions arising in the popliteal fossa are often found incidentally. Differential diagnosis of a mass in the popliteal fossa includes a number of pathologies. However, the lesion which is most commonly found in the popliteal fossa is Baker's cyst which is caused by a degenerative or inflammatory disease of the knee, although it may also be idiopathic. Other masses found in this area are: extra-articular ganglia cyst, hematoma, proliferation of adipose tissue, aneurysm of the popliteal artery, thrombosed varicose vein, gouty tophi (associated with gouty arthritis) and benign or malignant soft tissue tumors [1, 2]. Schwannoma is the most common benign peripheral nerve tumor. Nevertheless, only a few authors have so far reported on schwannomas of the common peroneal nerve [3, 4]. This lesion is traditionally detected and characterized with diagnostic imaging such as computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound (US) scanning.

In recent years, contrast-enhanced ultrasonography (CEUS) and US-elastography have been successfully used in different fields [5, 6]. However, only one study describes a rare case of hepatic schwannoma studied with CEUS [7] and only one case of leiomyoma studied with both CEUS and US-elastography has been reported [8].

This paper describes CEUS and US-elastography features of a rare case of schwannoma of the common fibular nerve. To the best of our knowledge, this is the first reported case of peripheral nerve schwannoma studied with CEUS and US-elastography.

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Case description

An 82-year-old male patient with a popliteal mass was referred to our department for US evaluation. He complained of a lump behind the knee, which had appeared at least 2 years before.

The patient reported symptoms ranging from discomfort to tenderness at the site of the lump, which was not really painful, however, and there was no sign of inflammation.

The lesion was located on the lateral side of the popliteal fossa along the course of the common fibular nerve. The lump was Tinel's sign negative and the patient said he had not experienced electric shock sensations. At the first consultation, the patient's general practitioner had, therefore, hypothesized that the lump was a popliteal fossa cyst.

US identified a 34 mm × 22 mm lesion characterized by well-defined margins and inhomogeneous hypoechogenicity, and color Doppler US showed some intralesional flow signals (Fig. 1a, b). The mass was in continuity with the common fibular nerve and the signal was similar to that of the nerve which seemed to be enlarged at the site of the mass (Fig. 1c).

After providing informed consent, the patient underwent CEUS performed with a low mechanical index (MI) after administration of sulfur hexafluoride (SonoVue, Bracco, Milan, Italy). At CEUS, the mass presented an inhomogeneous, strong enhancement which persisted for 1 min.

US-elasticity was performed using the ElastoScan technique and Samsung-Medison Accuvix A30 equipment (Seoul, South Korea) with a flat base 5–13 MHz probe. At elastography, the lesion appeared red in color revealing that the tissue was stiff and much harder than the surrounding muscles. Elasticity Contrast Index (ECI) was high, thus confirming the solid and stiff nature of the lesion. The lesion was eccentric in comparison with the upper and lower course of the nerve. In view of these features, the lesion was considered suspicious for peripheral nerve sheath tumor, particularly schwannoma.

MRI confirmed US findings and added other clues which indicated that the lesion was a schwannoma. In addition to the continuity with the common peroneal nerve, the lesion was encapsulated. The lesion appeared inhomogeneous on T2-weighted (T2W) images and iso-intense to the common peroneal nerve on pre-contrast T1-weighted (T1W) images, whereas T1W scans after gadolinium administration showed a strong, inhomogeneous enhancement. All these findings were in agreement with the hypothesis of schwannoma. The patient was submitted to surgery, and histological examination of the surgical specimen confirmed the diagnosis.

All procedures followed were in accordance with the ethical standards of the responsible committee on human

Fig. 1 **a** Gray-scale US shows an oval, iso-hypoechoic lesion with well-defined margins in direct continuity with the peripheral nerve branch. CEUS **(b)** shows marked and inhomogeneous contrast enhancement; **c** at elastography the lesion appears very stiff (red)

experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Written informed consent was obtained from the patient for the publication of this case report and accompanying images.

Discussion

In the presence of a popliteal swelling, the physician should take numerous diagnostic possibilities into account [9]. Backer's cyst is the most common. This cyst is usually asymptomatic, located on the medial side of the popliteal fossa and it is often associated with other knee disorders.

When Backer's cysts are not complicated by hemorrhagia or infection, they are located at the gastrocnemius-semi-membranosus bursa, and US appearance is anechoic [9]. When the lesions are heterogeneous, MRI may permit differentiation from other lesions.

Extra-articular soft tissue ganglion cysts appear as anechoic, well-defined masses, with no intralesional Doppler signal, sometimes with internal septation. Compared with Backer's cysts, they are often multilocular and deeper, and the cyst walls may be thick as ganglion cysts are not delimited by a synovial membrane but by an outer wall of fibrous connective tissue.

The importance of popliteal aneurism is linked to the risk of thrombosis which is rather high with ensuing symptoms of ischemia. Aneurisms are often bilateral (in 50–70 % of cases). Diagnosis may be difficult if the aneurism is completely thrombosed, as it may mimic other solid lesions at US examination.

Pigmented villonodular synovitis is a low-grade neoplastic lesion characterized by abnormal proliferation of histiocytes and giant cells, which usually contain hemosiderin which produces diffuse areas of low signal intensity on both T1W and T2W MRI scans; it is most often located in the popliteal fossa. US appearance of diffuse pigmented villonodular synovitis is nonspecific as it may appear as a hypoechoic synovial thickening or as an irregular mass located within the joint cavity associated with joint effusion. Color Doppler US may show hypervascularization of the lesion. The most common sites of giant cell tumors of the tendon sheath are the wrist and the hand. Other synovial lesions located at the knee joint are lipoma arborescens and synovial hemangioma which present characteristics similar to those of other hemangiomas causing recurrent episodes of knee swelling and pain despite no history of trauma.

Synovial sarcoma is most frequently located in the popliteal fossa and it is the fourth most common sarcoma accounting for 2.5–10.6 % of all primary soft tissue tumors. The three most common sarcomas are malignant fibrous histiocytoma, liposarcoma and rhabdomyosarcoma.

Tumors arising from the peripheral nerve sheath belong histologically to three main categories: schwannoma, neurofibroma and malignant peripheral nerve sheath tumor. US diagnosis of schwannoma is based on the detection of a solid hypoechoic, encapsulated tumor (the capsule is seen in about 70 % of schwannomas compared to only 30 % of

neurofibromas) in direct continuity with a peripheral nerve at its proximal and distal poles [10]. In most cases, schwannoma appears as a solitary globoid mass located along the peripheral nerve, eccentric to the nerve axis. It presents with homogeneously hypoechoic echotexture, posterior acoustic enhancement and a hypervascular pattern at color power Doppler [10]. Intralesional calcifications and cystic degeneration may be encountered [11].

In contrast, neurofibromas develop as a fusiform enlargement [12] and they are less vascularized than schwannomas. Color Doppler US may show the target sign consisting of a central, weakly hyperechoic area surrounded by more hypoechoic tissue due to the presence of a central fibrotic focus. Malignant transformation may be suspected in the presence of ill-defined margins and adhesions of the mass invading the surrounding tissues.

Today, both US and MRI are used to diagnose peripheral nerve tumors even though these techniques do not always provide the information required to distinguish between the different categories of nerve tumors. The morphology of a schwannoma on MRI scan is widely discussed in the scientific literature. The lesion appears as an encapsulated well-circumscribed, contrast-enhanced mass in continuity with the nerve; it is inhomogeneous on T2W scans and isointense to skeletal muscles on T1W scans [1].

More recently, US contrast agents and US-elastography have been proposed as additional diagnostic tools for the evaluation of various organs [5, 6, 8]. However, only one rare case of schwannoma of the liver studied with CEUS is reported in the literature, and there is no report describing schwannoma studied with elastography.

In their case report, Ota et al. reported that CEUS evaluation of a hepatic schwannoma showed weak blood flow within the septum and in the solid areas of the tumor in the vascular phase as well as cystic areas with no contrast uptake; the solid areas presented delayed enhancement in the post-vascular phase. MRI scan was hypointense on T1W images and inhomogeneously hyperintense on T2W images; gadolinium enhancement was not homogeneous in the arterial phase and lasted until the delayed phase [5].

These characteristics are in agreement with our MRI findings. CEUS showed a strong, inhomogeneous enhancement both in the early and in the late phases, and at elastography the lesion appeared homogeneously very stiff.

Neurofibroma and schwannoma have different outcomes after surgery. Neurofibroma cannot be removed without sacrificing the nerve, but a schwannoma can be isolated from the peripheral nerve, and local recurrence rate is low. Even though the current techniques cannot distinguish between these two tumors, it would be interesting to assess the full potential of the more recent diagnostic US tools such as elastography and CEUS using second generation

contrast agent to reap the benefits of future developments in diagnostic capability. US operators should be familiar with the features of the described lesions to promptly identify them and add valuable information to other imaging clues.

Conflict of interest Vito Cantisani, Nicola Orsogna, Cristina Fioravanti, Andrea Porfiri and Ferdinando D'Ambrosio declare that they have no conflict of interest related to this paper.

Informed consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). All patients provided written informed consent to enrolment in the study and to the inclusion in this article of information that could potentially lead to their identification.

Human and animal studies The study was conducted in accordance with all institutional national guidelines for the care and use of laboratory animals.

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