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Case Report

Use of contrast ultrasound in differentiating thrombosed pseudoaneurysm from sarcoma, prior to surgery

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ABSTRACT

We describe a case of a 69-year-old male with a right-sided popliteal mass following a motor vehicle accident 15 years ago. The mass was indeterminate via multiple modalities (magnetic resonance imaging, digital subtraction angiography, and vascular ultrasound) with biopsy requested prior to surgical removal to determine the appropriate surgical team – vascular versus sarcoma oncologic surgery. Contrast ultrasound was utilized to determine if biopsy was indicated and if so, to determine the most appropriate target. Contrast ultrasound showed no areas of enhancement, therefore biopsy was not performed and the patient safely proceeded to vascular surgery. Pathology confirmed the mass to be a thrombosed pseudoaneurysm of the popliteal artery. We present the benefits of using contrast ultrasound in the work up and diagnosis of a popliteal neoplasm versus suspected vascular complication.

Introduction

Contrast ultrasound is a modality that makes use of intravenous microbubbles for dynamic imaging. It was approved in the Unites States in 2014 for echocardiogram, and in 2016 for liver lesions and vesicoureteral reflux in pediatric patients [1], but has been in use globally for longer. Contrast ultrasound is commonly used in characterizing liver and renal lesions and its accuracy has been well documented [2,3]. Less common indications include vascular structure evaluation [4]. Endoleak evaluation after abdominal aortic aneurysm repair utilizing contrast ultrasound has been shown to be similar to gold standard computed tomography angiography to determine the presence and type of endoleak [5,6]. Contrast ultrasound is also able to differentiate bland versus tumor thrombus within the portal vein, in the setting of cirrhosis and hepatocellular carcinoma, respectively [7]. It has also proven useful in evaluating extremity sarcoma response to neoadjuvant chemotherapy [8] as well as in guiding percutaneous image-guided biopsies [9], by identifying viable vascular and necrotic tissue. Acquisition of both viable and necrotic tissue during

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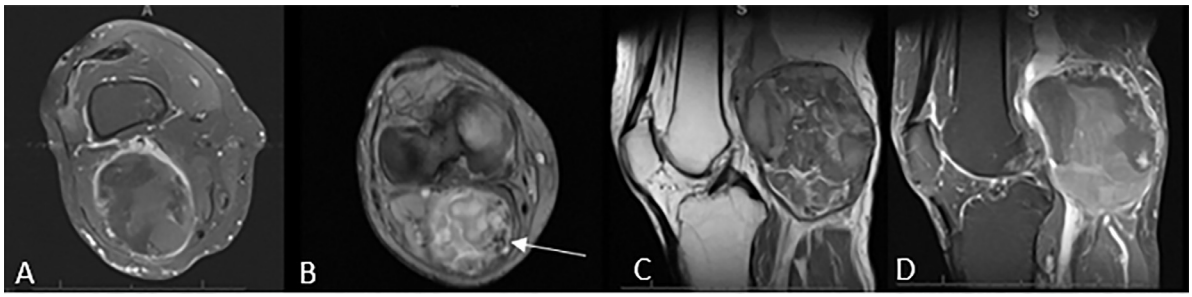

Fig. 1 – MRI sequences (A) postcontrast axial T1 with fat suppression, (B) Axial T2, (C) Sagittal T1 precontrast, (D) Sagittal fat-suppressed T1 post contrast, show a 8.8 x 7.4 x 11.1 cm heterogeneous, intermediate to low T1 and heterogeneous high T2 signal intensity mass with a peripheral rim of hemosiderin staining (arrow) as a result of chronic blood product degradation. There is no internal enhancement within the mass, however areas of intrinsic T1 hyperintensity may obscure enhancement in the absence of subtraction images.

sarcoma biopsy is important for accurate tumor grading [10]. A natural extension of these common uses is to leverage the utility of contrast ultrasound to diagnose the etiology of an indeterminate extremity lesion – vascular abnormality, such as pseudoaneurysm, versus soft tissue sarcoma – and then to guide potential biopsy prior to excision by the appropriate surgical team.

Case report

A 69-year-old male was referred to the vascular surgery service at our institution for evaluation of a large right popliteal mass. It had slowly increased in size over several years following a remote motor vehicle accident. At the time of his accident, he was told that he had a residual "hematoma" behind his knee, and per evaluations by both orthopedic and vascular surgeons, there was no involvement of the vessels. He then presented to the vascular surgery service at our institution several years later as the mass had recently become larger and painful. He also noted cramping of the right leg with walking, which improved with a compression sleeve as well as with rest.

On physical exam, the vascular surgeon noted a well-circumscribed, nontender, nonmobile mass that measured approximately 13 × 10 cm. There was no erythema. There were prominent veins noted around the mass and chronic venous stasis changes isolated to the right lower extremity. He had monophasic dorsalis pedis and posterior tibialis Doppler signals on the right, whereas he had palpable pulses on the left foot.

Duplex ultrasound (not shown) revealed a heterogeneous structure in the popliteal fossa with arterial branches off of the proximal popliteal artery, which were thought to supply the structure. Given the finding of a possible vascularized mass, there was concern for malignancy and a prior contrast-enhanced magnetic resonance imaging (MRI) that had been performed at an outside institution (Fig. 1) was submitted for internal consultation, noting that the original read was unavailable. This showed a mass-like structure in the popliteal fossa with heterogeneous intensity, chronic hemosiderin staining, and lack of apparent enhancement (subtraction images were not provided), which was favored to represent a thrombosed pseudoaneurysm.

Given discrepant interpretations between the MRI and vascular ultrasound, the patient underwent diagnostic angiography to evaluate the vascularity around and inside the mass (Fig. 2). No flow was seen within the mass, as would be expected of a completely thrombosed pseudoaneurysm, however a necrotic neoplasm could have a similar appearance.

An ultrasound-guided biopsy was ordered by the vascular surgeon. To target the highest yield tissue for biopsy, a contrast-enhanced ultrasound was performed to both diagnose and guide a potential percutaneous biopsy of the lesion.

Contrast ultrasound was performed with radiologists present to definitively diagnose the lesion and to guide the potential biopsy at the same visit. The patient was imaged in prone positioning with a 6 megahertz curved transducer on a Siemens S2000 ultrasound unit (Siemens, Malvern, PA). Grayscale and color Doppler images were first obtained (not shown) followed by imaging after the administration of 2 mL of Lumason intravenously (sulfur hexafluoride lipid-type A microspheres, Bracco Diagnostics Inc, Monroe Township, NJ), followed by a 5 mL sterile saline flush (Fig. 3). One bolus was used to image early and late phases and "burst" technique was used to break all bubbles within the imaged field of view to allow reperfusion of an individual area without requiring a second dose of contrast. No contrast enhancement was noted within the mass during both early and delayed imaging postcontrast injection – the imaged lesion appeared as a "black hole" on the contrast-only images. However, in one area there was a linear area of possible enhancement within the sac (Fig. 3C). Given its linearity, it was felt to be artifact – and this area was persistent both prior to and after reperfusion using the burst technique, proving it represented pseudo-enhancement and not vascularized tissue, as strongly echogenic acoustic interfaces, such as gallstones or bowel, can be visible on the contrast images, but most importantly will also be visible prior to bubble injection [11].

Torturous arterial vessels were also seen proximal to the lesion during the contrast ultrasound, which filled simultaneously with the proximal popliteal artery, identical to those seen on digital subtraction angiogram. There was no enhance-

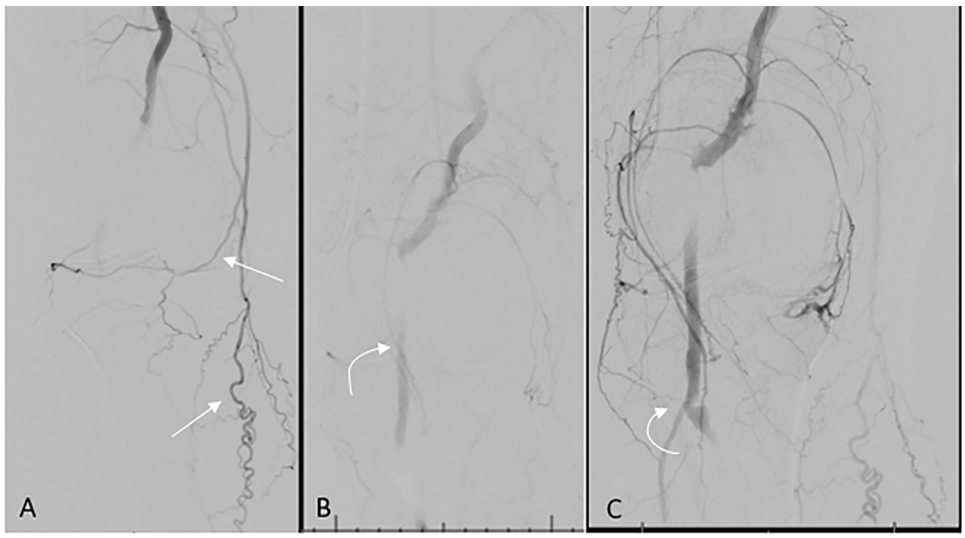

Fig. 2 – (A) Digital subtraction angiography from anterior-posterior view showed minimal flow through the behind the knee popliteal artery and no internal vascularity was noted within the mass. Also noted was extensive collateralization around the mass (arrows) (B-C) and opacification of the distal popliteal artery predominantly via collaterals (curved arrow).

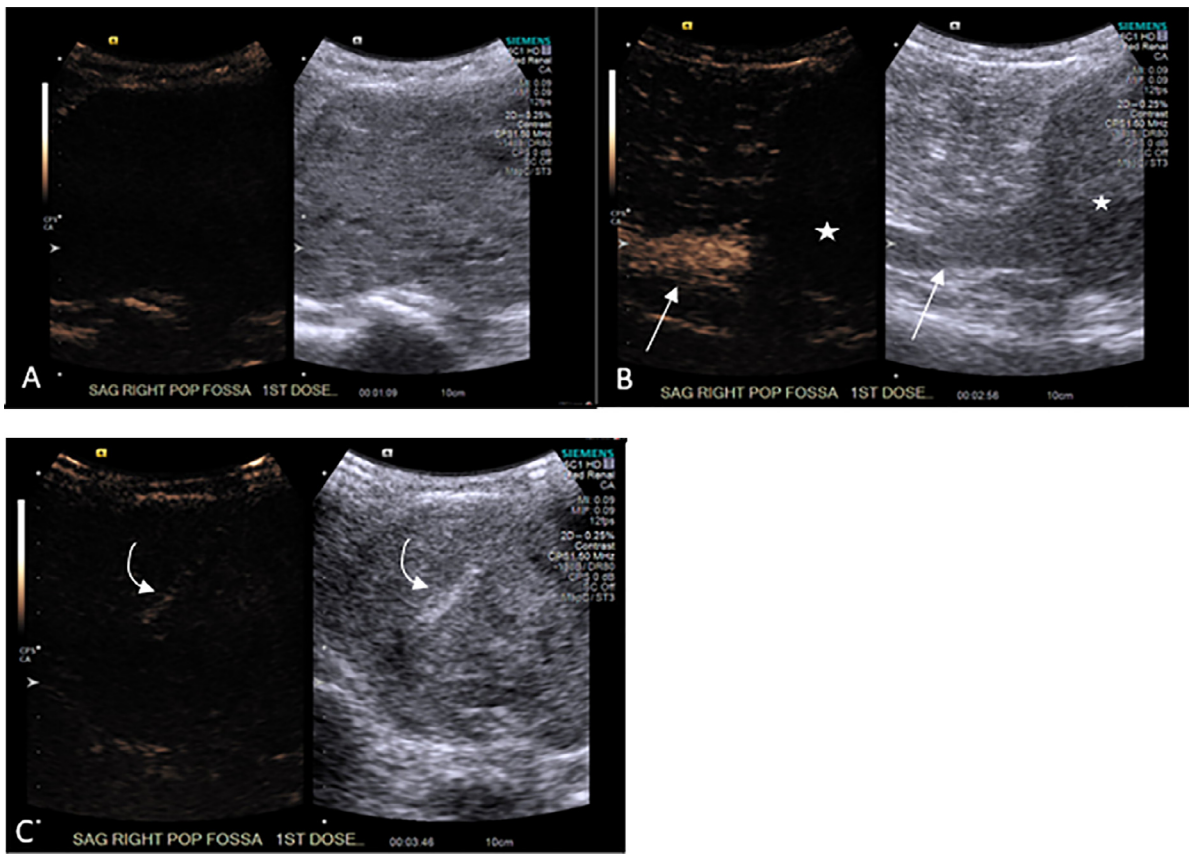

Fig. 3 – Contrast enhanced ultrasound images. (A) Early images show no enhancement within the heterogeneous lesion on the contrast only (left) image, a "black-hole." Right-sided low MI grayscale image shows that the main portion of the heterogeneous lesion was being imaged. (B) Confirms enhancement within the proximal popliteal artery (arrow) and soft tissues proximal to the lesion. No flow was seen in the popliteal artery deep to the lesion (star), or within the lesion. (C) Linear pseudoenhancement within the lesion (right) from a bright, linear acoustic interface that is also seen on grayscale (curved arrow). Flash, or burst technique was used to reperfuse this area to prove this was pseudoenhancement and not true enhancement (not shown).

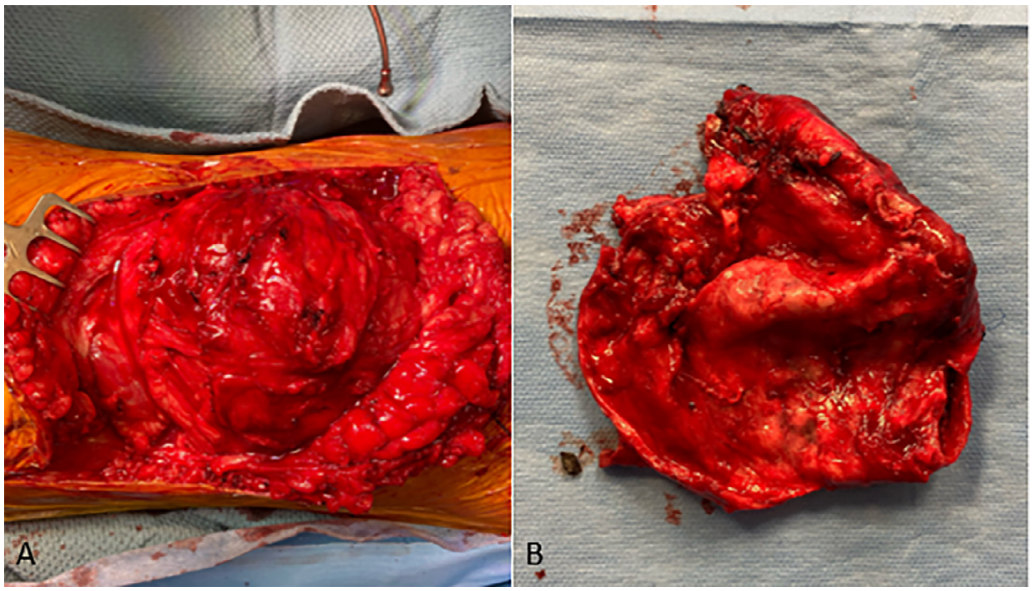

Fig. 4 – (A) In vivo, well-vascularized capsule of the large popliteal mass. (B) Fibrous capsule of the pseudoaneurysm.

ment within the lesion after contrast administration, indicating no viable tissue. Even a highly necrotic tumor prior to any treatment will have some viable tissue, and thus enhancement. Given the close proximity of the lesion to the popliteal artery, history of trauma, and MRI and contrast ultrasound findings, a completely thrombosed pseudoaneurysm was diagnosed. No biopsy was performed as no enhancing tissue was present to target, and the patient was safely and confidently booked for vascular surgery.

The patient subsequently underwent resection of his popliteal mass (Fig. 4), which was filled with liquefied blood. There was extensive vascularity surrounding the mass, as well as involvement of the popliteal vessels – both the artery and vein were reconstructed. Final pathology confirmed the mass was negative for malignancy and consisted of a fibrous capsule with organizing thrombus.

Discussion

Our patient was evaluated by multiple specialties and modalities for a chronic, but enlarging and painful mass in the popliteal fossa. Given discrepant imaging interpretation between modalities, a definitive diagnosis was unclear and the vascular surgeon required confirmation before potentially inappropriately removing a sarcomatous mass. Contrast ultrasound was utilized to verify the etiology of the lesion and assess the utility of preoperative biopsy.

The differential for masses in the popliteal fossa is large, but can be generally classified into intra- or extra-articular origin of the pathology as outlined in Figure 5, adapted from Shah et al [12].

In our case, hemosiderin deposition within the mass on MRI could be mistaken for hemorrhagic synovium in the setting of pigmented villonodular synovitis, however no clear intra-articular component or communication was identified. Additionally, internal enhancement of the synovium in pigmented villonodular synovitis is expected, which is not present in a completely thrombosed pseudoaneurysm and thus this could confidently be excluded [13].

Soft tissue sarcomas have a variety of appearances and degrees of vascularity, including mixed signal on T1 and T2 sequences. Central necrosis is often a feature of high-grade sarcomas, which can mimic a thrombosed pseudoaneurysm, requiring careful evaluation for enhancing internal solid components within the mass on the postcontrast sequences [14].

Given downstream negative effects associated with removing an unsuspected sarcoma, such as residual tumor left behind with a higher recurrence rate, preoperative percutaneous biopsy would be useful in determining the appropriate surgical team to remove the lesion. Fine needle aspiration (FNA) of a thrombosed pseudoaneurysm is likely safe, as similar or even larger gauge needles can be used to inject thrombin to treat pseudoaneurysms under ultrasound guidance [15,16]. However, increased bleeding complications could be incurred if core biopsy was performed to increase the diagnostic yield [17]. While uncommon, false negative results during sarcoma biopsy with FNA are possible, particularly in borderline or low-grade spindle cell variants, or necrotic neoplasms [18–20].

In our practice, we found that direct discussion between the vascular surgeon, a musculoskeletal radiologist, and an abdominal radiologist with experience in contrast ultrasound was useful in guiding the next steps in the most efficient manner for the patient. A contrast ultrasound could be both diagnostic and aid in targeted biopsy performed at the same appointment.

Considering the MRI findings, the FNA result was likely to be negative as the lesion was presumed to be a pseudoaneurysm. However given the vascular ultrasound interpretation and the rare possibility the lesion was a sarcoma, a false negative biopsy could be catastrophic to the patient's

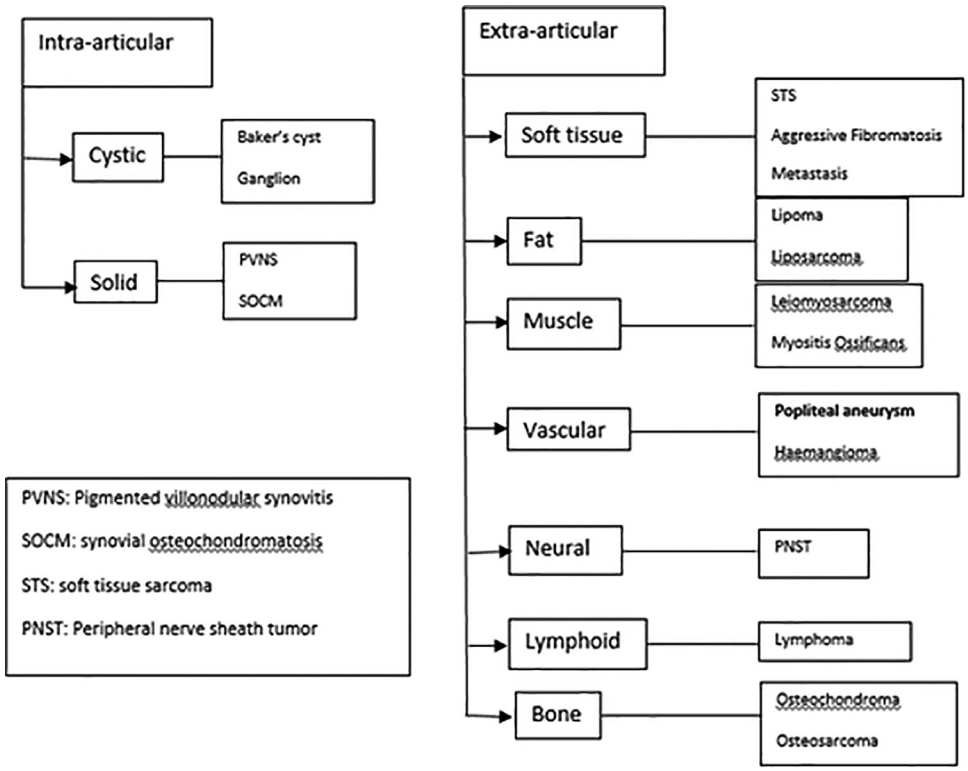

Fig. 5 – Differential for popliteal fossa masses, adopted from Shah et al. [Shah].

surgery and treatment. Contrast-enhanced ultrasound is cost-effective and less time consuming than a repeat contrast-enhanced MRI with subtraction imaging. It does not require screening of renal function or for internal metal objects prior to imaging. Another benefit of contrast ultrasound over repeat MRI is the opportunity for both a diagnostic study and image-guided biopsy at the same appointment. If the lesion was a thrombosed pseudoaneurysm, no internal flow would be seen via contrast ultrasound and therefore no biopsy would be required. If it was incompletely thrombosed, vascular flow within the pseudoaneurysm should be identifiable, similar to endoleak in a grafted abdominal aortic aneurysm [21], which would be useful preoperative information to the vascular surgeon. If there was focal, soft tissue-type enhancement, it would be targeted for biopsy at the same visit, and would have a higher expected yield than a random FNA biopsy [8,22]. The patient could then be referred to the appropriate surgical specialist.

A similar case was reported in 2018 by Villaescusa Catalán et al [23]. They report a patient who presented with intermittent claudication requiring vascular stenting of the popliteal artery. He subsequently developed an aneurysm at the site requiring ligation and bypass. Eight years later, he came to the emergency department with a painful mass in the popliteal fossa. Ultrasound differential diagnosis was between a popliteal artery pseudoaneurysm and soft tissue tumor. Emergent surgical intervention was performed with final pathology revealing the mass to unfortunately be an angiosarcoma. Given the similar presentation and the initial findings for a vascular mass on ultrasound, caution, and multimodality confirmation was appropriate. In our case, the best outcome for the patient relied upon the most appropriate initial surgical intervention and was dependent upon the correct preoperative diagnosis.

A contrast examination includes standard ultrasound to identify a lesion or abnormality, followed by intravenous microbubble contrast administration. Postcontrast imaging is shown on a split-screen view including a low B-mode gray scale image (to reduce bubble destruction by more powerful ultrasound waves) alongside of a subtraction type image, which shows any tissue that enhances. Imaging is dynamic, instead of well-timed snapshots that are utilized in computed tomography and MRI postcontrast and yields real-time diagnostic information. The microbubbles remain intravascular and burst after several minutes of imaging and/or during circulation, so more than one dose can be given during an exam [24–26]. The byproducts are exhaled via the pulmonary circulation, so renal function screening is not necessary [25].

For our patient, the contrast-enhanced ultrasound allowed direct visualization of the mass and dynamic imaging of any potential residual vascular or soft tissue component, which could be used to direct biopsy and the subsequent surgery. Contrast-enhanced ultrasound has shown high negative predictive value in excluding the presence of flow in solid-appearing masses and is useful in evaluating for vascular flow and leaks in aneurysms [4,21,22]. Contrast ultrasound is inexpensive, has no radiation, and has a low allergy risk profile, rendering it a potentially useful modality for superficial

structure evaluation both in diagnosis and in planning biopsy and surgery. It can be used as a first or second line modality for diagnosis as well as biopsy guidance and should be considered in the work-up of indeterminate extremity lesions of presumed vascular origin.

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