Real-time MR Imaging Guidance for Percutaneous Core Biopsy of US- and CT-negative Lesion

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ABSTRACT

Biopsies traditionally are performed under ultrasound (US), computed tomography (CT), or fluoroscopic guidance. In situations in which lesions are difficult to visualize with US or CT guidance, magnetic resonance (MR) imaging often can provide better imaging results. The authors describe a case in which a recurrent calf mass not well visualized under fluoroscopy, CT, or US was identified on MR imaging. In the absence of real-time needle visualization, percutaneous interventions under MR guidance have been limited by prohibitively long imaging times. A novel guidance system providing real-time MR guidance of needle position was used to procure a core biopsy specimen of the lesion.

Biopsies traditionally are performed under ultrasound (US), computed tomography (CT), or fluoroscopic guidance. In situations in which lesions are difficult to visualize with US or CT guidance, magnetic resonance (MR) imaging often can provide better imaging results (1). Traditional MR-guided procedures typically require moving the patient in and out of the MR gantry because no currently available solutions allow for real-time MR guidance. This results in prolonged procedure times for MR-guided interventions when compared with US or CT, in which real-time guidance is currently available. The authors describe a case in which a mass not well visualized under fluoroscopy, CT, or US was identified on MR imaging. A novel real-time MR guidance system was used to guide biopsy of the lesion.

CASE REPORT

Patient Presentation

The institutional review board at our hospital does not require review or approval for single-study reports of clinical experience such as this. A healthy 37-year-old white man presented to the interventional radiology clinic with a 2-month history of pain in the right calf on exertion. The patient had a history of a mass in the calf. The lesion had been partially resected surgically 10 years before, and the pathology report suggested the presence of an aneurysmal bone cyst. However, the lesion persisted and continued to grow, and the diagnosis of hemangioma or vascular malformation was considered. The lesion subsequently was labeled a hemangioma and was embolized with intraarterial ethanol in three separate sessions 8, 4, and 1 year before the patient's presentation to the interventional radiology clinic. Each embolization was followed by a pain-free interval until symptoms recurred. By the end of the most recent embolization procedure, the vascular supply of the lesion had markedly dwindled over time, and no residual arteriovenous shunting was present. Endovascular approaches were no longer viable options. Percutaneous ablative options (eg, cryoablation) were presented to the patient. He remained asymptomatic for the next 4 months, when recurrent pain prompted his visit to our office.

The patient expressed concern that the lesion might be malignant based on interval increase in size noted on imaging of the cranial half of the lesion. Although the transformation of an aneurysmal bone cyst into an osteosarcoma is exceptional, other malignant lesions could not be ruled out in this patient with an ambiguous and undetermined diagnosis. We decided to perform a percutaneous biopsy to (i) exclude a diagnosis of malignancy and (ii) clarify the actual diagnosis before any additional treatment. Although the lesion could be clearly seen on MR imaging, neither US nor CT provided good visualization (**Fig 1**).

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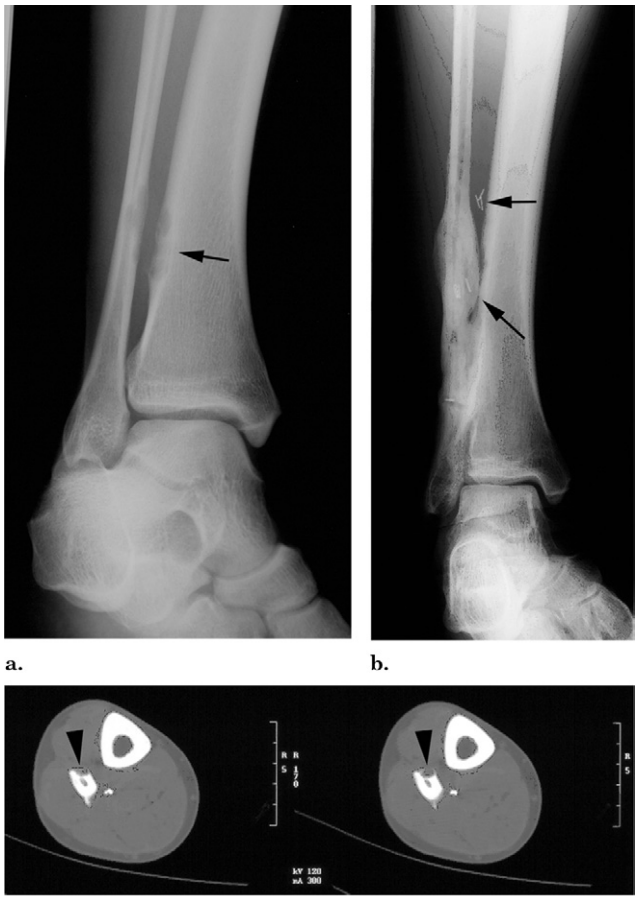

Figure 1. **(a)** Plain radiograph at initial presentation (9.5 y before the MR-guided biopsy described in the present report), before any treatment (lesion is indicated by the arrow). **(b)** Plain radiograph obtained 1 year after partial surgical resection; the arrows indicate surgical clips placed 7 y before MR-guided biopsy. **(c)** Noncontrast CT image obtained 2 years after surgery (5.5 y before MR-guided biopsy; arrowheads indicate the lesion).

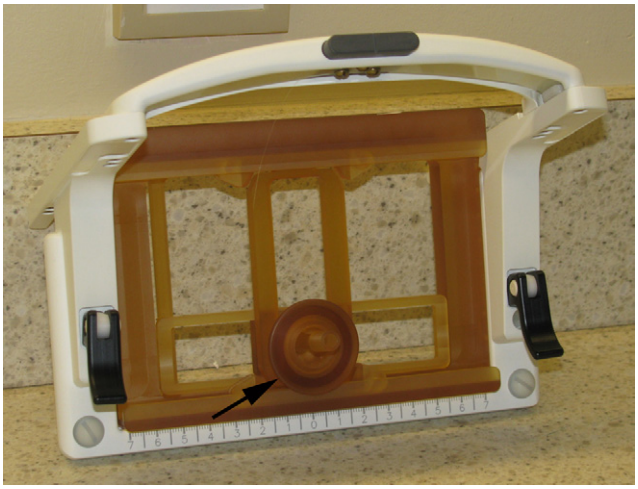

Figure 2. Needle holder placed inside the opening of an existing transmit–receive coil. The holder allows translation in two dimensions and needle angulation at a ball joint (arrow). The tracking sensor is embedded within the holder to allow definition of the needle path by using real-time navigation. (Available in color online at *www.jvir.org*.)

Procedure

A wide-bore 1.5-T MR scanner (Espree; Siemens, Malvern, Pennsylvania) was used for image guidance in the biopsy procedure. An oil-tablet fiducial marker was placed on the skin to mark the symptomatic site. T1- and T2-weighted images were obtained in all three spatial planes. To facilitate navigation, a custom-built support frame was placed in the opening of the transmit–receive extremity coil (**Fig 2**). This frame has a custom needle holder that can be translated in two dimensions and allows needle angulation at a ball joint. This system allows definition of the needle trajectory in a wide range of approach angles. The procedure was performed under local anesthesia. Based on previously acquired anatomic images, real-time spatial localization sequences were used to provide annotation on anatomic images to determine the biopsy trajectory (**Fig 3**) with the patient still inside the magnet. This was accomplished by using a Food and Drug Administration–approved magnetic gradient field–based stereotactic tracking system (Endoscout; Robin Medical, Baltimore, Maryland) with a sensor embedded at the joint of the needle holder and an MR-compatible monitor.

After confirmation of the selected path, a 16-gauge MR-compatible titanium coaxial needle (Invivo, Pewaukee, Wisconsin) was advanced through the holder while its position was followed on the screen by high–frame-rate two-dimensional MR images aligned along the needle axis (**Fig 4** and **Video**, available online at *www.jvir.org*). MR scan parameters were as follows: echo time, 4.16 ms; repetition time, 15 ms; flip angle, 15°; field of view, 160 × 160 cm with 1-mm in-plane voxel resolution; slice thickness, 5 mm; bandwidth, 260 Hz/pixel, and temporal resolution of 2.4 s. During the intervention, periods of dynamic imaging were approximately 1 minute long (30 images). After reaching the target position, core biopsy specimens were obtained with a 16-gauge titanium MR-compatible semiautomatic biopsy gun (Invivo). The coaxial system was removed, pressure was maintained over the access site, and hemostasis was achieved within 2 minutes.

Pathologic analyses of the biopsy specimens showed a bland spindle-cell proliferation with abundant osteoclast-type giant cells, along with scattered inflammatory cells and hemosiderin-laden macrophages. A rare minute spicule of bone was identified within the lesion. No significant mitotic activity was found. The final diagnosis was giant-cell–rich neoplasm. Although the differential diagnosis of giant-cell–rich neoplasms is relatively broad, the features in this case were most consistent with an aneurysmal bone cyst or giant-cell tumor. Both these lesions can arise in bone or soft tissue, although aneurysmal bone cyst of soft tissue is quite rare.