Three patients with clinically suspected pseudoaneurysm as a complication of femoral puncture were referred for ultrasound (US) evaluation with both conventional duplex Doppler US and color Doppler imaging. Pseudoaneurysm (n = 2) and simple hematoma (n = 2) were depicted with both Doppler systems, and a separate pseudoaneurysm and a hematoma were found in one patient. These diagnoses were confirmed surgically. Distinctive Doppler spectral waveforms and color Doppler findings enabled confident diagnoses. Color Doppler imaging allowed faster detection of intraneurysmal flow, and the track between the injured artery and the pseudoaneurysm was identified only with color Doppler imaging. Duplex Doppler US with color Doppler imaging allows for the rapid, unequivocal diagnosis of pseudoaneurysm, thus enabling prompt treatment without the need for invasive diagnostic modalities.

FEMORAL artery pseudoaneurysm is an uncommon complication of femoral artery puncture, the frequency of which is increased by anticoagulation, hypertension, or improper technique (1-5). It is a pulsatile hematoma that results from leakage of blood into the soft tissues anterior to the femoral artery, with subsequent fibrous encapsulation and failure of the defect in the vessel wall to heal (1-3, 6, 7). A patent channel between the vessel and the fluid space is thus maintained, and blood flows into and out of the pseudoaneurysm during the cardiac cycle (6-8). Since it is not a true aneurysm, in that it is not lined by a complete arterial wall (2, 7, 9), a pseudoaneurysm requires prompt surgery to prevent subsequent expansion or rupture (2, 4, 10, 11).

Pseudoaneurysms usually present as focal masses near the site of arterial puncture. They must be differentiated from simple hematomas, which do not require surgery. It can be difficult to differentiate intrinsic pulsations from transmitted pulsations, and pulsations may be obscured by overlying hematoma. Thus, palpable pulsatility of the mass is a nonspecific clinical sign (2, 7). While an audible systolic bruit over the mass is suggestive of pseudoaneurysm, this is not present in all cases (2). Thus, angiography is commonly necessary for definitive diagnosis, although angiographic findings may be subtle (6-8).

Duplex Doppler ultrasound (US) has proved useful in the diagnosis of many vascular abnormalities (12-14), but its use in the diagnosis of femoral artery pseudoaneurysm has not, to our knowledge, been reported. A recently developed advance in Doppler technology, color Doppler imaging, promises to extend the utility of Doppler imaging by displaying flow and structure in a single two-dimensional image (15, 16). We present three cases of suspected femoral artery pseudoaneurysm in which the differentiation of pseudoaneurysm from hematoma was possible with conventional duplex Doppler US supplemented by color Doppler imaging. A typical image and spectral waveform for a pseudoaneurysm are described, and easily avoidable potential diagnostic pitfalls are discussed.

MATERIALS AND METHODS

Case Material

Three patients with suspected femoral artery pseudoaneurysm were referred for US examination. These patients had undergone cardiac catheterization and had subsequently received anticoagulation therapy for immediate cardiopulmonary bypass graft surgery. Three to 5 days after surgery, a focal pulsatile mass with an audible bruit was noted near the site of arterial puncture, and pseudoaneurysm was suspected. The US diagnosis in each case was subsequently confirmed surgically. Repeat angiography to confirm the diagnosis was not performed in any case.

US Technique

All patients were initially examined with conventional B-mode and Doppler US imaging with a commercially available duplex unit (Ultramark 4; Advanced Technology Laboratories, Bellevue, Wash.) equipped with a 5-MHz mechanical sector duplex transducer. Following duplex scanning, patients were examined with a color Doppler unit (Quantum Medical Systems, Issaquah, Wash.) with the use of both 5- and 7.5-MHz linear phased-array transducers. This examination was recorded digitally and reviewed with a frame-by-frame playback.

A color Doppler image is generated by processing the reflected ultrasound echoes not only for amplitude, as is done for conventional B-mode US imaging, but also for phase and frequency (15). A shift in frequency between transmitted and received ultrasound, or Doppler shift, can therefore be calculated for each pixel in

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2 RSNA, 1987
3 See also the article by Shimamoto et al. (pp. 683-685) in this issue.
an image. The direction of flow relative to the transducer in each pixel is displayed as either red or blue. With the color Doppler unit used in this study, velocity relative to the transducer, which is proportional to the frequency shift, is displayed as saturation of color. In other words, deep shades of red or blue represent relatively slow velocities, while increasing flow velocity is represented as increased “whiteness” of the color.

RESULTS

Diagnoses

In two patients, pseudoaneurysm was identified at both duplex and color Doppler examination, while only a simple hematoma was found in the third patient. In one of the patients with a pseudoaneurysm, an additional simple hematoma was noted several centimeters away from the pseudoaneurysm. These diagnoses correlated with the surgical findings in all three patients.

Duplex US Findings

Pseudoaneurysm and simple hematoma could not be distinguished on the basis of B-mode findings alone. Both entities appeared as complex collections with anechoic portions, and unequivocal pulsatility could not be demonstrated in any collection.

Pulsed Doppler evaluation revealed turbulent pulsatile flow within both pseudoaneurysms, establishing the diagnosis. In one of these patients, a distinctive “to-and-fro” Doppler waveform was observed at the neck of the pseudoaneurysm, consisting of high-frequency flow (5-8 kHz) toward the transducer throughout systole and intermediate-frequency flow (2-4 kHz) away from the transducer throughout diastole (Fig. 1). The distance between the nearest artery and the pseudoaneurysm was approximately 1 cm in each patient. In neither patient with a pseudoaneurysm was the track connecting it to the artery clearly demonstrated.

Color Doppler Imaging Findings

In both patients in whom diagnoses of pseudoaneurysm were made on the basis of Doppler findings, a high-velocity flow jet was noted entering the pseudoaneurysm at its neck during systole, with eddy currents of flow away from the transducer noted on either side of the jet (Figs. 2, 3). During diastole, swirls of color filled the collection, and continuous flow leaving the pseudoaneurysm was seen at the neck. In both patients, the tracks connecting the pseudoaneurysm with the artery were easily detected, appearing as straight lines with high-velocity flow toward the pseudoaneurysm throughout systole and away from the pseudoaneurysm throughout diastole.

The range gate of the color Doppler unit allowed for duplex scanning of the neck of the pseudoaneurysm and the track leading to it. In these sites, the distinctive to-and-fro waveform was seen.

DISCUSSION

The three cases in this series demonstrate the ability of both conventional duplex Doppler US and color Doppler imaging to allow differentiation of pseudoaneurysm secondary to arterial puncture from hematoma. This is an important differential diagnosis, because a pseudoaneurysm must be resected promptly to prevent expansion or rupture (2, 4, 10, 11), while a simple hematoma is usually managed conservatively.

B-mode US has been reported as useful for differentiating pseudoaneurysm from nonpulsatile hematoma, because of the capability of demonstrating visible pulsatile expansion of the pseudoaneurysm and echoes within hematoma (4). In our series, echogenicity was not useful, since both hematomas and pseudoaneurysms had anechoic portions. We were not able to identify pulsatile expansion reliably, perhaps because of surrounding clot or fibrous tissue. Other modalities have been suggested as alternatives to arteriography, such as intravenous digital subtraction angiography (11) and dynamic computed tomography (4). These modalities share the disadvantage of requiring intravascular administration of contrast material, however, and are thus more invasive than Doppler examination.

Conventional duplex Doppler and color Doppler imaging are both capable of depicting pseudoaneurysm of the femoral artery by demonstrating arterial pulsations within an anechoic space in proximity to an injured vessel. If the neck of the pseudoaneurysm or the track leading to it is examined with pulsed Doppler, a distinctive spectral waveform can be obtained with either Doppler system. This waveform, which has not to our knowledge been previously described in the literature, consists of holosystolic high-velocity flow toward the transducer followed by holodiastolic flow of intermediate velocity in the opposite direction, a pattern that is typical of pseudoaneurysm. During systole, blood flows from the injured artery into the pseudoaneurysm. As arterial pressure drops during diastole, blood leaves the pseudoaneurysm and reenters the artery (1). Because the pressure gradient between the pseudoaneurysm and the artery is lower during diastole than during systole, a lower velocity of flow is noted during diastole.

The contribution of color Doppler
imaging in our series was to allow faster and more complete analysis of intraaneurysmal flow. While the same information might have been obtained with conventional duplex Doppler US, more skill and effort would have been required. With color Doppler imaging, the neck of the pseudoaneurysm was readily identified, as was the track connecting the injured artery with the pseudoaneurysm. This anatomic information, if communicated to the surgical team preoperatively, can facilitate repair of the pseudoaneurysm.

An easily avoidable potential pitfall of color Doppler imaging is artefactual color noise, which can fill anechoic spaces. Color noise can easily be differentiated from flow because (a) it is a homogeneous mixture of red and blue pixels that demonstrate random change only, (b) a corresponding Doppler audible or spectral waveform cannot be obtained, and (c) it can be eliminated if the color threshold and gain are set properly.

In conclusion, we have described a distinctive Doppler spectral waveform that reflects the characteristic...
pattern of flow within a pseudoaneurysm. When observed in the groin following arterial trauma, we consider this waveform to be strongly suggestive of pseudoaneurysm. While conventional duplex Doppler US can depict flow within a pseudoaneurysm and thus establish the diagnosis, color Doppler imaging facilitates detection of the neck of the pseudoaneurysm and the track connecting it with the injured artery, and helps localize the range gate for pulsed Doppler examination. Duplex Doppler US with color Doppler imaging allows the rapid, unequivocal diagnosis of pseudoaneurysm to be made, thus permitting its prompt treatment without the need for the use of invasive diagnostic modalities.

References


