Evaluation of Traumatic Groin Arteriovenous Fistulas with Duplex Doppler Sonography

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Femoral arteriovenous fistula is a rare complication of percutaneous transfemoral catheterization. We report the duplex Doppler findings of three such cases. Continuous positive diastolic arterial flow, as well as an abnormal venous flow pattern, was observed in all cases. When present, these Doppler spectral changes support the diagnosis of arteriovenous fistula. KEY WORDS: arteriovenous fistula, duplex Doppler, sonography, femoral artery. *(J Ultrasound Med 8:21, 1989)*

Traumatic femoral arteriovenous fistulas are a rare complication of percutaneous femoral artery and femoral vein catheterization. These fistulas are important to recognize because they can lead to congestive heart failure, can cause venous insufficiency in the involved lower extremity, and may lead to aneurysm formation with associated risk of vascular thrombus and infection.

Arteriography has been the procedure of choice in diagnosing arteriovenous fistulas. We report the use of duplex Doppler sonography in evaluating traumatic groin arteriovenous fistulas.

MATERIALS AND METHODS

A retrospective analysis by duplex Doppler sonography of four patients (two men, two women) diagnosed as having femoral arteriovenous fistulas between September 1985 and December 1987 was undertaken. The patients ranged in age from 38 to 78 years (mean = 60 years). All patients had had recent transfemoral cardiac catheterization (median duration of 1 day, range of 1 to 61 days). Two patients were referred because of a questioned arteriovenous fistula and two patients for arteriopathology (pseudoaneurysm v hematoma v arteriovenous fistula).

All patients had routine gray-scale scanning as well as duplex Doppler analysis. A totally uniform scanning procedure was not followed although all patients underwent linear array scanning with 5 or 7.5 MHz transducers. Duplex range-gated Doppler equipment (Acuson 128, Mountain View, California) was used on one patient and color flow imaging (Quantum Medical Systems, Issaquah, Washington) was used on one patient. Two patients were scanned with both systems.

Confirmation of diagnosis was by surgery (two patients), angiography (one patient), and clinical evaluation (one patient). The patient diagnosed by clinical evaluation was an intravenous drug user who refused angiography or surgery, although this was recommended by a vascular surgeon on the basis of clinical findings consistent with arteriovenous fistula (continuous bruit at femoral artery catheter site).

RESULTS

Arteriovenous fistulas were confirmed in three of the four patients sonographically diagnosed as having arteriovenous fistula. One patient (1 day postcatheteriza-

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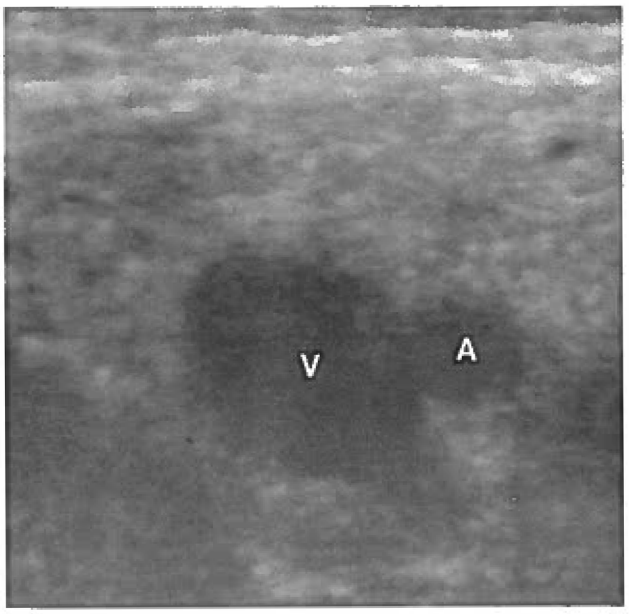

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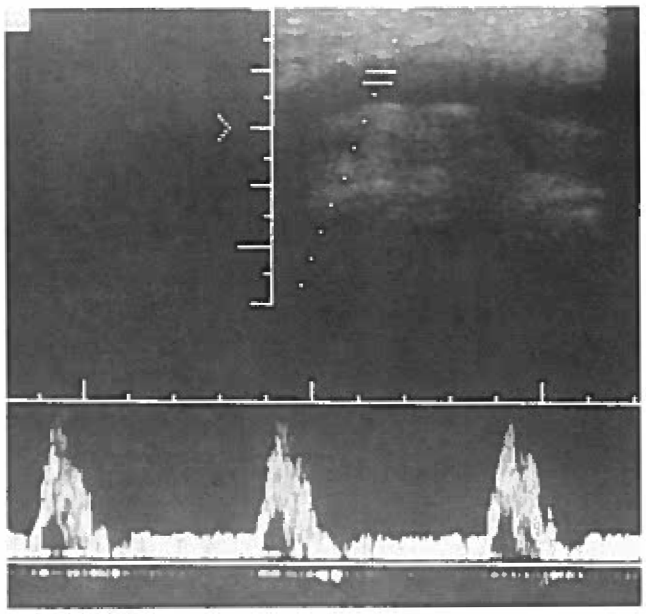

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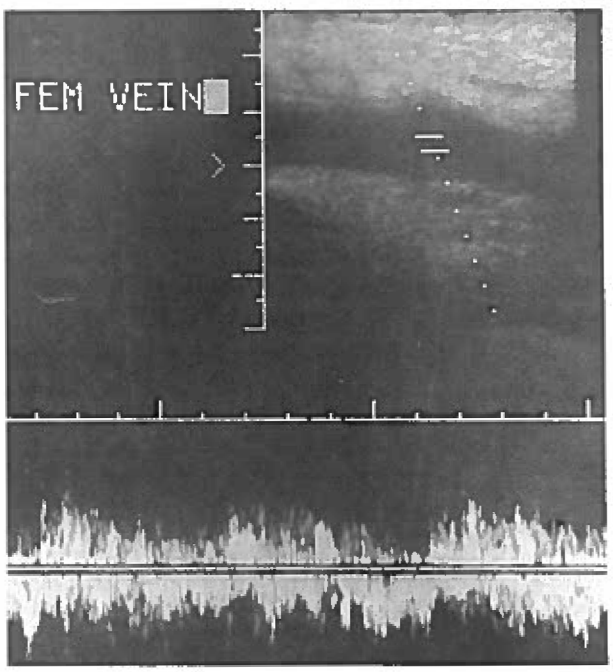
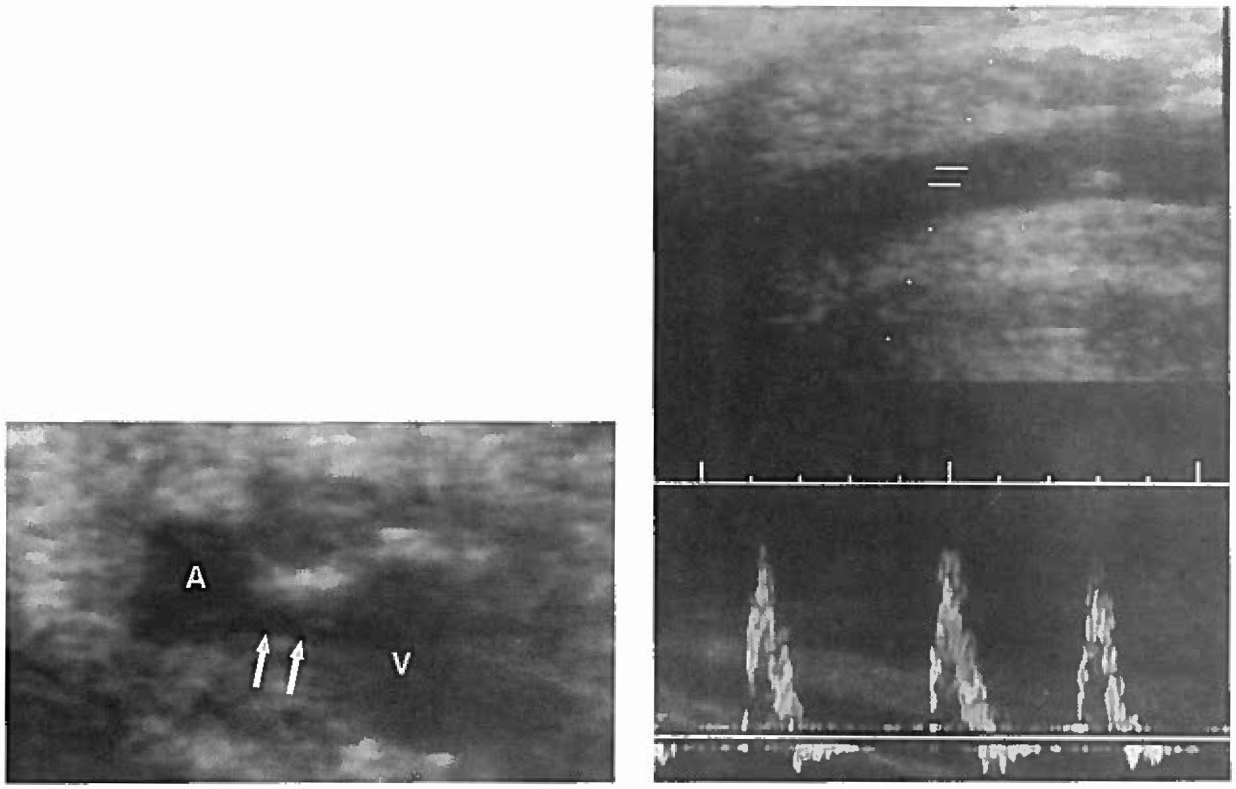


C

Figure 1 Traumatic arteriovenous fistula of the groin. **A,** Axial sonogram demonstrates dilated femoral vein (V) adjacent to femoral artery (A). **B,** Duplex Doppler signal of femoral artery proximal to arteriovenous fistula. Note the continuous positive flow throughout diastole and the absence of the normal early diastolic flow reversal. There is a subtle early diastolic dip in the otherwise rather uniform diastolic flow. **C,** Duplex Doppler signal of femoral vein proximal to arteriovenous fistula. Note the abnormal chaotic bidirectional flow pattern.

tion) sonographically diagnosed as having an arteriovenous fistula had a normal arteriogram 6 hours after ultrasound. Although it is conceivable that an arteriovenous fistula was present and later clotted prior to the angiogram, this case undoubtedly represents a false positive study.

Retrospective analysis of the four sonographic studies demonstrates that in all three cases of true arteriovenous fistula, continuous positive diastolic arterial blood flow was identifiable by duplex Doppler in the proximal portion of the feeding artery (Fig. 1B). A brief dip in the positive diastolic flow signal sometimes occurred at the start of diastole. Interestingly, our erroneous sonographic case failed to demonstrate this continuous diastolic arterial flow (Fig. 2B). The Doppler signal in the vein proximal to the fistula either demonstrated very



A B

Figure 2 False positive arteriovenous fistula. **A,** Axial image demonstrates presumed fistula *(arrows)* between artery (A) and vein (V). Angiogram six hours later was normal. **B,** Femoral arterial Doppler signal demonstrating normal spectrum including early diastolic flow reversal.

chaotic flow pattern (two patients, Fig. 1C) or appeared to be a composite of a normal venous signal with superimposed arterial signal (one patient, Fig. 3). The venous signal in the patient without demonstrable arteriovenous fistula demonstrated neither of these patterns.

The gray-scale findings of the three cases of arteriovenous fistula showed the artery and vein to be adjacent to each other at the presumed fistula site although the actual communication was difficult to pinpoint without the use of the Doppler probe. In two of the three cases, the femoral vein was dilated (Fig. 1A). In the other case, the femoral artery and vein at the site of the presumed fistula were approximately equal in diameter. The false positive case showed the femoral artery and vein to be adjacent to each other and a presumed fistula was seen (Fig. 2A). In this false positive case, the gray-scale findings actually contributed to the erroneous diagnosis.

DISCUSSION

An acquired arteriovenous fistula is an abnormal direct communication between an artery and vein, bypassing the normal capillary bed. These generally result from arterial or venous trauma (eg, laceration of adjacent artery and vein). They may lead to high-output congestive heart failure, aneurysm formation, infection, and venous insufficiency of the lower leg.[1] The classic clinical findings are a palpable thrill and a continuous murmur at the site of the arteriovenous fistula.[1]

Utility of duplex Doppler sonography in evaluating traumatic femoral arteriovenous fistula has not been published, although there have been rare reports of duplex Doppler findings of visceral arteriovenous fistula.[2,3] The normal arterial Doppler signal in the femoral artery is a positive systolic spike followed by an early diastolic flow reversal and late, low-frequency, diastolic positive flow.[4] The abnormal finding of continuous femoral arterial positive diastolic blood flow in the artery proximal to the arteriovenous fistula was found in all three patients with this condition. This wave-form pattern has been previously suggested.[5] The single patient erroneously diagnosed as having an arteriovenous fistula (false positive) lacked this particular diastolic flow component in the proximal femoral artery. We feel this may be a useful sign in aiding the sonographer when arteriovenous fistula is questioned in a posttraumatic groin study. Additionally, all cases of arteriovenous fis-

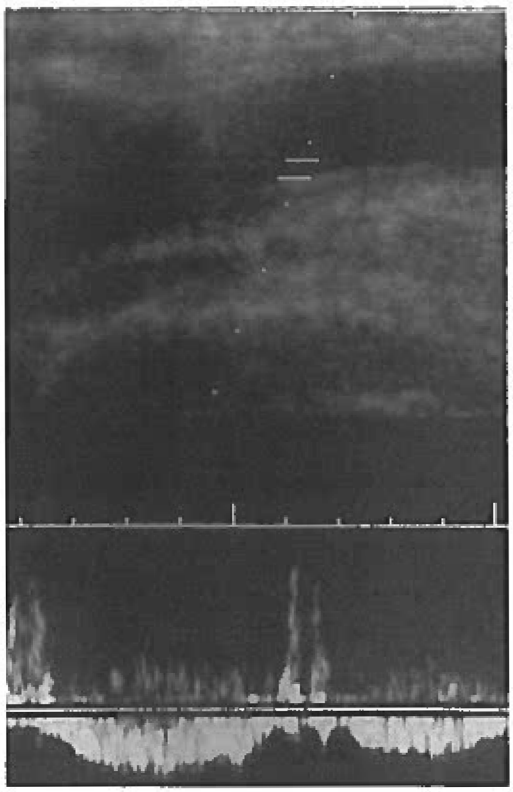


Figure 3 Duplex Doppler signal of femoral vein near site of arteriovenous fistula demonstrates a composite of the normal venous signal and an arterial systolic spike.

tula had abnormal venous flow spectrums. Two of three cases had associated femoral vein dilatation, a condition known to occur clinically with arteriovenous fistula,[5] which has also been described by sonography.[6]

Positive diastolic flow could be expected to occur in any arterial system when a positive pressure gradient is maintained in diastole. This obviously occurs in the case of a traumatic arterial (high-pressure) to venous (low-pressure) fistula. Early and mid-diastolic positive flow can also be seen in the femoral artery when peripheral resistance is high, as present in peripheral vascular occlusion disease as well as distal to a stenosis; although in the latter case, other wave form changes may be present.[7,8] Exercise, reactive hyperemia, and other conditions associated with peripheral vasodilatation may also lead to diastolic flow, especially when associated with a proximal stenosis.[7] Other causes of arteriovenous shunt, such as an arteriovenous malformation, might produce abnormal arterial and venous signals although gray scale findings may clarify the diagnosis. However, the absence of continuous positive diastolic flow in the proximal artery associated with normal venous flow argues against a hemodynamically significant arteriovenous fistula.

Doppler spectral analysis may be helpful when a traumatic femoral arteriovenous fistula is questioned by clinical evaluation or by gray-scale findings. Our results show that a continuous positive diastolic arterial flow pattern in the proximal feeding artery associated with abnormal venous flow supports the diagnosis of traumatic femoral arteriovenous fistula. Angiography should remain the definitive diagnostic test until these findings are further supported.

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