Peripheral Arteriovenous Malformation: Diagnosis and Localization by Intraarterial Injection of Technetium-99m-MAA

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Radionuclide angiography with technetium-99m-labeled macroaggregates of albumin (^{99m}Tc-MAA), was successful in a single patient with a lower limb arteriovenous (AV) malformation, not only in diagnosis and quantitation of AV shunting, but also in localizing the site of shunting. This information proved useful to the angiographer, permitting a carefully tailored examination of the area of interest. This technique may hold promise as a preliminary examination in patients with limb AV malformations prior to angiography.

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Diagnosis and localization of the site and extent of peripheral arteriovenous (AV) malformations is usually accomplished by contrast angiography. This may be technically difficult in some instances, particularly when there are no clinical signs (e.g., bruits) to indicate the approximate site for detailed study at angiography. Radionuclide angiography using technetium-99m-labeled particles (macroaggregates of albumin (^{99m}Tc-MAA) or microspheres) has been used previously to document and quantify peripheral AV malformations (*1*,*2*). We report the additional use of this technique, as an adjunct to angiography, in determining the site of shunting, in a single patient with an AV malformation of the lower limb.

CASE REPORT

A 19-yr-old female patient was referred for investigation of increasing size of her left lower limb. This had been progressing slowly for ~7 yr. Clinical examination revealed hypertrophy of her left thigh and calf and a 2-cm disparity in length between both legs. There were no clinically detectable bruits or evidence of varicose veins. The patient was otherwise asymptomatic and in good health. A clinical diagnosis of an AV malformation was made and the patient referred for angiography.

At angiography, the left femoral artery was catheterized, contrast injected, and the whole limb was examined using a rapid sequence film changer and a moving table. The site of AV shunting was not clear from this general examination. The patient was then taken to the nuclear medicine department and ^{99m}Tc-MAA was injected into the left femoral artery. The technique of radionuclide angiography has been described previously (*1*), but briefly, depends on the trapping of radiolabeled particles by the capillary bed of the region to be studied. When an AV malformation is present, this normal trapping process is circumvented, as particles pass through the AV malformation or fistula into the venous system and hence to the lung fields.

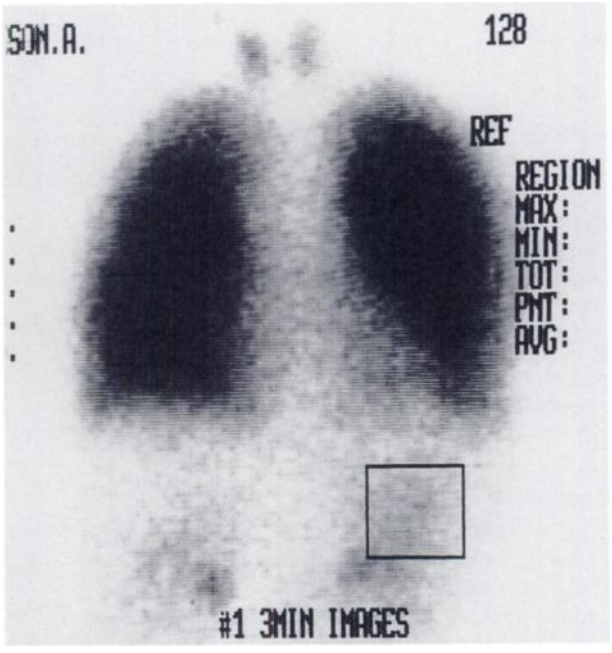

FIGURE 1
A static image, taken with the gamma camera centered on the thoraco-abdominal area, 3 min post intraarterial injection of 5 mCi of ^{99m}Tc-MAA. Regions of interest can be seen over the right lower lung field and the left upper abdomen. Total counts collected from these areas yielded AL and AB, respectively. Concentration of the radiolabeled particles can be seen in the lungs, having passed through the AV malformation.

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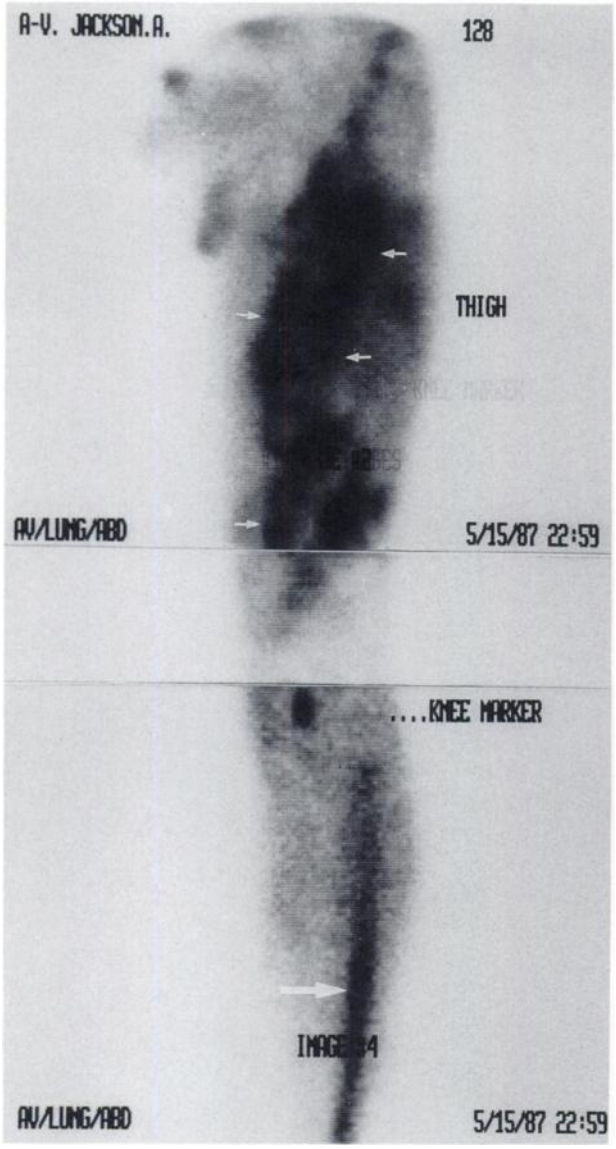

FIGURE 2
Two-minute image taken of the left lower limb, after intraarterial injection of ^{99m}Tc-MAA. Accumulation of the radioisotope is seen in tortous venous channels in the thigh (small arrows). A single linear column of radioisotope is seen below the knee in the short saphenous vein (large arrow). More normal appearing capillary trapping of the radiolabeled particles is also seen below the knee.

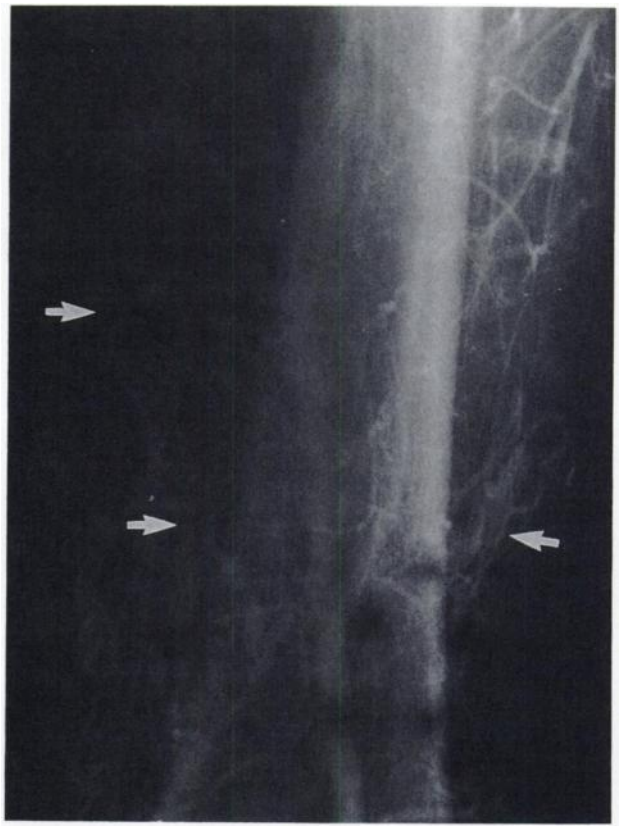

FIGURE 3
Contrast angiography revealed early filling of a number of deep venous structures consistent with arterio-venous shunts (arrows).

Technique

A preliminary low activity (0.5–1.0 mCi) venous injection of pertechnetate (^{99m}Tc) is first administered to establish a distribution ratio. After 3–5 min, a static image is taken of the thoraco-abdominal area and total counts are collected from regions of interest (ROIs), defining lung and body (VL and VB). An intraarterial injection of 5 mCi of ^{99m}Tc-MAA is then administered in bolus fashion. At an equilibration time of 3 min, a further static image is obtained of the thoracoabdominal area and total counts from identical ROIs yield arterial values (AL and AB) (Fig. 1). An increase in the ratio between lung field and body reference is due to MAA appearing in the lung capillaries and indicates the presence of an AV shunt. A ratio method of quantitation is given by the formula (VB * AL)/ (VL * AB). Normal values are between 0.8 and 1.16 (*2*). In this patient, the ratio was 3, confirming the presence of an AV malformation.

In addition, a static computer image was taken of the left leg at 2 min postinjection of the radiopharmaceutical. This showed concentration of the radiolabeled MAA particles in the thigh in a series of multiple discrete linear collections consistent with abnormal venous channels (Fig. 2). A single linear concentration of radioisotope is seen extending from the knee inferiorally consistent with retrograde flow into the short saphenous vein from the dilated veins above the knee (Fig. 2). Elsewhere below the knee a more homogenous appearance of radioisotope uptake is seen consistent with uptake by the lower leg capillaries.

A tailored angiographic study was then repeated with special reference to the knee area and sequential films revealed early filling of veins in the knee region consistent with several AV shunts (Fig. 3). A conservative management approach was adopted at that time and the patient was discharged.

DISCUSSION

Arteriovenous malformations represent a difficult therapeutic challenge requiring detailed knowledge of the location and extent of the lesion prior to surgery. Angiography is currently the principal method of evaluating vascular malformations (*3,4*). However, clinical

examination to determine the approximate site and extent of the AV malformation is mandatory so that a proper combination of film size, changer and angiographic technique is utilized (*5*). Helpful clinical features include, the presence of a bruit, varicose veins, and the clinical extent of the soft-tissue swelling. Occasionally, even with a localized AV malformation, enlargement of the whole limb may occur due to edema, widespread enlarged vessels, or overgrowth of bones and/or soft tissues (*5*). This makes clinical localization difficult in these patients.

Radionuclide angiography, using radiolabeled particles for the diagnosis and quantitation of AV malformations has been described previously (*5*). Quantitation of the size of the vascular malformation is not only useful for diagnosis but is also useful as a baseline for comparing future follow-up studies post-therapy. The additional use of this technique for localizing the approximate site of the AV malformation was useful in selecting the correct angiographic technique in this patient. Tortuous venous collections of ^{99m}Tc-MAA could be seen above the knee compared to the more normal capillary distribution of the radiolabeled particles below the knee (Fig. 2). This localized the level of shunting to the knee region, permitting a more tailored angiographic examination, at which the site of shunting was confirmed (Fig. 3).

In conclusion, ^{99m}Tc-MAA angiography proved useful in determining the level of shunting in this patient, who did not have localizing clinical signs. This information permitted a more tailored angiographic examination of the area of interest. We are currently evaluating this technique in a series of patients with AV malformations.

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