The "Tourniquet Effect"

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There is increasing popularity of three-phase bone scintigrams in the evaluation of soft tissues and bony disorders. However, if the areas in question happen to be hands, wrists, and forearms, the usual method of injection of a radiotracer may introduce a significant abnormality during the first two phases of a three-phase study.

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On a number of occasions, we have noticed increased vascularity in the hands, wrists, and forearms, on the side of the injection, during a three-phase bone study of these regions. Since injections were made on the clinically normal side; hyperemia during the blood-flow and blood-pool images on the normal side could not be explained on a pathological basis. Since delayed images of the study were essentially normal on the side of injection in all these patients, we considered the possibility of reactive hyperemia induced by transient ischemia in the parts distal to the tourniquet or blood-pressure cuff. Figure 1 illustrates one such case in a young man referred to us for pain in the right wrist during the 8 mo following an injury. Injection in the left arm shows intense vascularity of the forearm and hand during the dynamic and blood-pool phases on the left. Clinical examination, as well as delayed images, were normal on that side. To confirm this observation, the following experiment was done.

METHOD AND RESULTS

Three-phase bone scintigrams of the hands, wrists, and forearms were obtained on four patients who were referred for evaluation of metastatic disease. None of these four had any signs, symptoms, or history of soft-tissue or bony abnormalities of the forearms and hands. The injection technique was as follows. Both forearms and hands were placed on the detector of a gamma camera. A blood-pressure cuff was applied to the *right* upper arm or proximal forearm. The cuff pressure was raised in the manner described by Oldendorf et al. (*1*). A 19-gauge, 1-in. butterfly with 12-in. of plastic tubing was inserted into the *left* antecubital fossa *without application* of a *tourniquet*. Twenty millicuries of Tc-99m methylenediphosphonate (MDP) were rapidly injected and flushed with 10 ml of normal saline using a three-way stop cock. At the same time the blood-pressure cuff on the contralateral arm was released. Dynamic images were obtained for 48 sec with one frame every 3 sec. Next, a blood-pool image was obtained for 300,000 counts. A second blood-pool image was also obtained ~1–2 min after the first, for the same number of counts. A whole-body image was obtained ~3 hr after the injection. Figure 2 shows findings typical of all four patients. An arrow marks the distal border of the blood-pressure cuff. Marked vascularity is noted during both the dynamic and the blood-pool phases after the release of pressure cuff. The second blood-pool image, and the delayed images (not shown), were symmetrical and normal.

DISCUSSION

There is important clinical information in the dynamic flow study and the immediate blood-pool images of a three-phase bone series. When the area of interest happens to be forearms, wrists, and hands, the injection technique may introduce a significant artifact if the effect of a tourniquet is not allowed for. As reported here, routine injection techniques as described by Oldendorf et al. (*1*) do produce significant tissue ischemia, followed by reactive hyperemia during the first few minutes after the pressure is released. A simple tourniquet should cause similar findings—in fact, the patient in Fig. 1 was injected with a simple tourniquet.

Local arterial perfusion is controlled by small arteries and arterioles, and to a lesser extent by the capillaries and the smallest veins. The precapillary arterioles control the amount of blood being delivered to the tissues. They also control the number of open capillaries, which in turn determine the exchange surface. The caliber of the arterioles is controlled by local metabolic processes, in addition to sympathetic and parasympathetic nerves and circulating hormones. Precapillary sphincters are predominantly under local control. The precise mechanism of local factors affecting blood flow is not clear, but locally produced metabolites seem to have a complex effect on the arterioles and precapillary sphincters. These vasoactive substances include released norepinephrine, acetylcholine, carbon dioxide, lactic acid, histamine, etc.

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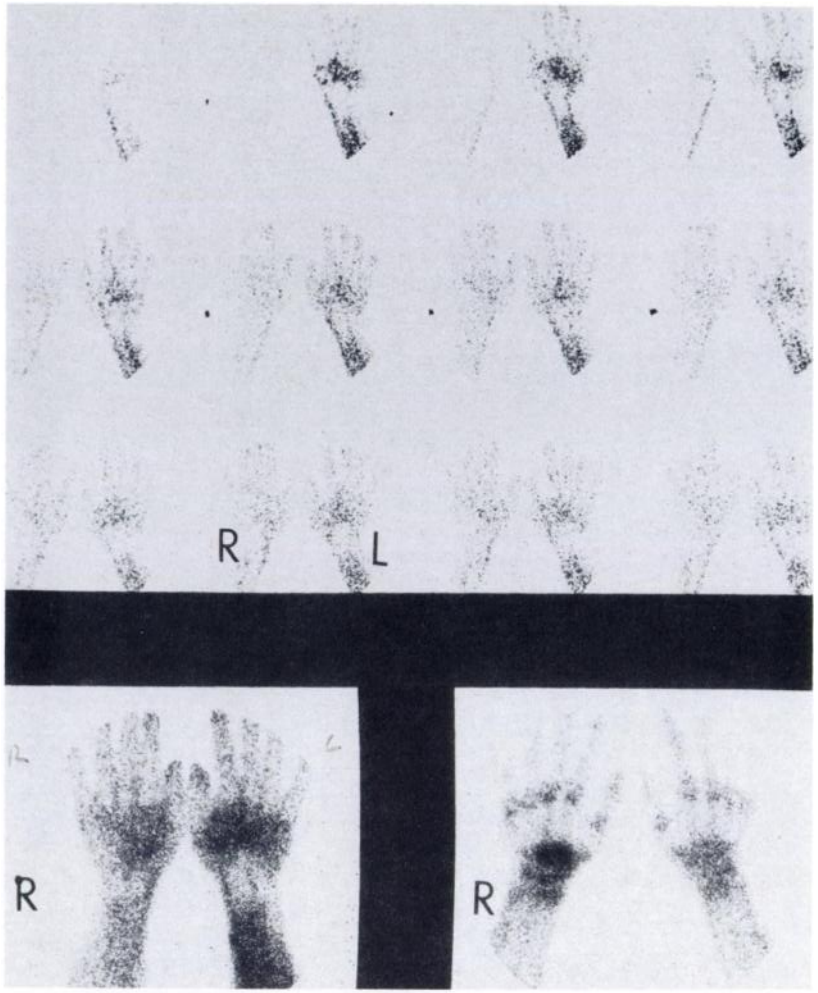

FIG. 1. Increased vascularity on left side in flow study (top) and blood-pool image (bottom left) in patient injected in left antecubital vein using regular tourniquet, with patient's palms resting on camera face. At lower right is later image showing normal picture on uninjured, but injected, left side.

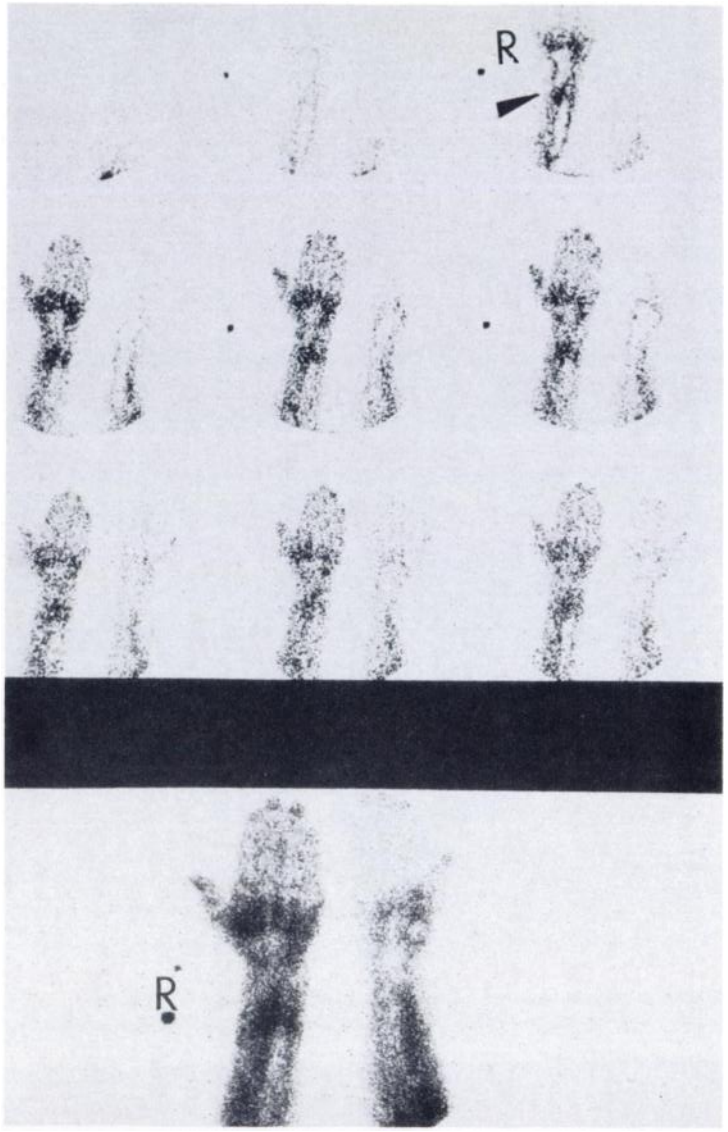

FIG. 2. Hyperemic changes during flow study (top) and blood-pool image (bottom) in right forearm and wrist after release of blood-pressure cuff. Injection was made, without tourniquet, in left antecubital vein, with dorsum of patient's hands resting on camera. Arrowhead marks distal border of blood-pressure cuff.

In prolonged ischemia or vasoconstriction, accumulation of "vasodilator metabolites" can relax the precapillary sphincters to allow increased blood flow. Local metabolites actually override the remote control and provide some degree of local autonomy to forestall tissue damage (*2*).

We recommend therefore that when a flow study or a three-phase bone study of the upper extremity is to be performed, the venipuncture should be done without a tourniquet and the radio agent should be flushed rapidly with normal saline. If a tourniquet is applied for venipuncture, one should wait ~5 min after the tourniquet is released for reactive hyperemia to subside.

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