

Abnormal Peripheral Distribution of Thallium-201 due to Arteriosclerosis

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A diminution of regional blood flow to any part of the body should be demonstrable after the administration of a radionuclide whose distribution is determined by regional blood flow. The distribution of ²⁰¹Tl in canine myocardium has been found to correlate closely with regional myocardial flow determined by microspheres or with ⁴³K [1]. Additionally, its extracardiac distribution in canine thyroid, kidney, and skeletal muscle has been found to correlate with blood flow to these organs as determined by microspheres [2]. In humans, the agent has been widely used as an effective detector of both stress-induced regional myocardial ischemia [3, 4] and myocardial infarction or scar [4-8].

The utility of ²⁰¹Tl in the study of blood flow to cardiac muscle is now well established. Its effectiveness for the clinical evaluation of blood flow to skeletal muscles, such as those of the extremities, has not been as thoroughly documented. This report describes an individual with clinical and angiographic evidence of stenosis of the right subclavian artery who demonstrated a corresponding abnormality on a total body image after ²⁰¹Tl was intravenously injected.

Case Report

A 59-year-old male construction worker was admitted with symptoms of cerebral ischemia and claudication of the legs. He had a history of heavy tobacco use, but there was no history of arm pain or symptoms suggestive of coronary artery disease. Blood pressure was 158/95 in the right arm and 190/88 in the left arm. Carotid pulses were 3+/4 bilaterally, and bilateral carotid bruits were present. The peripheral pulses in the arms were asymmetrical: the right brachial pulse was 2+, the right radial pulse was 1+, and the left brachial and radial pulses were 3+. No femoral, popliteal, or pedal pulses could be palpated. There was an absence of hair below the knees.

Contrast angiography of the aortic arch and abdominal aorta demonstrated bilateral carotid stenoses and total occlusion of the abdominal aorta below the level of renal arteries. Severe stenosis of the right subclavian artery just beyond its origin from the aorta was also demonstrated (fig. 1).

Surgical therapy for both the carotid and abdominal aortic disease was considered. Because of the widespread nature of the arteriosclerosis, a preoperative assessment of the extent of disease and of surgical risk was desired, and an exercise myocardial perfusion study using ²⁰¹Tl was performed. During the treadmill exercise, the patient did not develop angina or electrocardiographic ST changes, but was forced by leg pain to cease exercise. An intravenous injection of 2 mCi of ²⁰¹Tl was given when he achieved his maximal level of treadmill exercise, which was continued for an additional minute. Myocardial images were obtained immediately after the termination of exercise and again after a 4 hr period of rest. Additionally, a

postexercise total body image (fig. 2A) was obtained, just after the exercise myocardial imaging was completed. The two postexercise imaging procedures were completed within 40 min of injection.

The myocardial perfusion study (not shown) demonstrated exercise-induced ischemia. The total body image (fig. 2A) demonstrated prominent activity in the heart and abdominal viscera and a paucity of activity in the bones, genitalia, elbows, knees, and ankles. The skeletal muscles had substantial activity which made apparent an asymmetry in the appearance of the arms; the entire right arm and shoulder showed diminished activity. When compared to the legs of normal subjects, the legs appeared to have a symmetrical reduction of radioactivity (fig. 2B).

Discussion

A variety of radionuclide techniques has been developed to estimate blood flow in the extremities. Early methods were based on measurements of the rate of clearance from an injection site of trace amounts of ²⁴NaCl [9-11], ¹³³Xe in saline [11], or Na ¹³¹I [12] and did not allow imaging of regional blood flow.

A second method for studying regional peripheral perfusion used regional intraarterial injections of labeled albumin microspheres or particles of macroaggregated albumin. Subsequent images provided a visual representation of blood flow at the capillary level [13], and results obtained from these studies have correlated well with clinical data [14, 15]. However, the particle perfusion technique has the disadvantages of intraarterial injection and/or catheterization.

There is a rational basis for anticipating that radioactive thallium may be a useful indicator of regional blood flow to skeletal muscle. Sapirstein [16] found that intravenously injected ⁴²K distributes in accordance with regional blood flow, and ²⁰¹Tl and ⁴²K exhibit similar patterns of uptake and retention in rat skeletal muscle [17] in addition to similarities of biochemical behavior [17, 18]. Furthermore, intravenous ²⁰¹Tl and intraarterial ^{99m}Tc-labeled microspheres have been found to have similar distributions in canine heart, thyroid, kidney, and skeletal muscle [2].

Assessment of regional blood flow by radioisotopic methods can be enhanced by exercise. Muscle contraction has been reported to augment the uptake of rubidium or potassium in canine skeletal muscle [19, 20], and in man it has been found that ²⁰¹Tl images after exercise show more activity in skeletal muscle than do images of patients injected at rest [21]. The value of exercise for increasing the sensitivity of imaging techniques in the detection of coronary artery disease is generally appre-

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Fig. 1.—Contrast angiogram of thoracic aorta showing severe stenosis of proximal right subclavian artery (arrow) as well as bilateral stenoses of carotid arteries (arrows).

ciated; this enhancement has also been found for perfusion studies of the legs using ^{99m}Tc -labeled albumin microspheres [14]. Thus the asymmetric distribution of ^{201}Tl in skeletal muscle in our patient may reflect the effects of exercise superimposed on his underlying vascular disease.

A recent report discussed the correlation between thallium uptake patterns in the lower extremities and clinical and angiographic data in patients with arterial insufficiency [22]. Our findings show a similar correspondence of information in an upper extremity. We believe that this information is noteworthy in that it suggests the possible use of imaging with ^{201}Tl as a noninvasive method to study peripheral regional blood flow.

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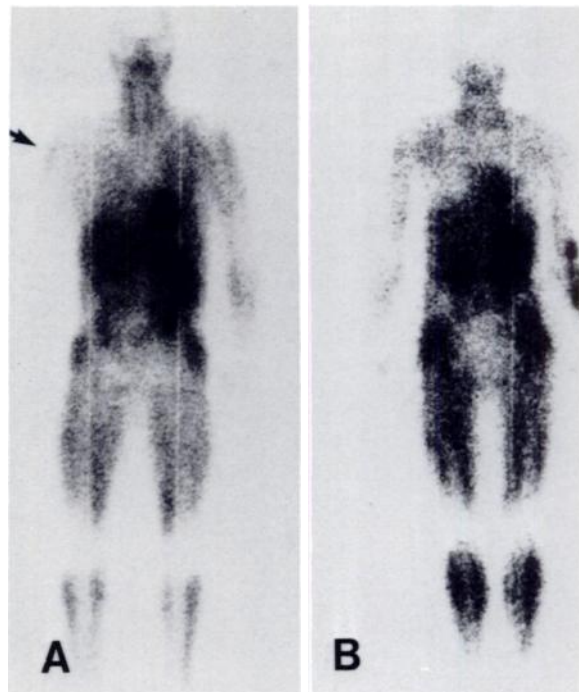


Fig. 2.—Total body ^{201}Tl exercise images of two patients, anterior views, showing prominent activity in myocardium, abdominal viscera, and skeletal muscle with paucity of activity in brain and in predominantly bony structures of extremities, such as knees, ankles, and elbows. A, Present case. Note asymmetry in appearance of upper extremities with decreased activity in right arm and shoulder (arrow). There is uniform reduction of activity in legs. B, Patient without clinical evidence of peripheral vascular disease. Activity in shoulders and arms is symmetrical except for activity at left side injection site.

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