Letters to the Editor

Technetium-99m Pyrophosphate Scintigraphy in a Patient with Malignant Hyperthermia

TO THE EDITOR: Malignant hyperthermia (MH) is a pharmacogenetic disorder, which is triggered particularly by potent inhalational anesthetics. Generalized destruction of the skeletal muscles is one of the main manifestations of MH (*1*, *2*). Cardiac functions are altered during the hyperthermic crisis, as evidenced by tachyarrhythmias, and, eventually, cardiac arrest ensues. A controversy exists, however, whether or not the cardiac muscle is involved in this disorder (*3–5*). Scintigraphy with technetium-99m pyrophosphate ([^{99m}Tc] PYP) has been recently introduced to demonstrate the muscle injuries such as acute myocardial infarction (*6–8*) and MH (*9*). We document our experience of this disorder, in which the scintigram demonstrated the absence of myocardial involvement following recovery from cardiac arrest at the malignant hyperthermic crisis.

A 13-yr-old boy, weight 45 kg, was scheduled for the removal of a tibial tumor. He had been in good health, and the preoperative physical and laboratory examinations did not show any abnormal findings. Anesthesia was induced with thiopental and was maintained with halothane (1–3%) in oxygen. Two minutes after the induction, muscle contracture was noted in the abdomen and the lower extremities and multifocal ventricular arrhythmias developed. The patient, easily intubated without aid of muscle relaxant, was ventilated with oxygen, and the halothane was discontinued. The rectal temperature at this time was 38.6°C and an arterial blood sample showed pH: 6.86; $PaCO_2$: 120 mmHg; base excess: −16.6 mEq/l; PaO_2: 522 mmHg; serum potassium: 6.9 mEq/l. Body cooling by alcohol sponge, intragastric lavage with cooled saline, and intravenous infusion of cooled lactated Ringer's solution were initiated immediately. Dantrolene, sodium bicarbonate, regular insulin, and furosemide were administered intravenously. Within 40 min of the induction, the metabolic and respiratory acidosis were corrected and the temperature, having reached a peak of 39.9°C, began to decrease. Nevertheless, the serum potassium level further increased to 7.4 mEq/l, and severe bradycardia and succeeding cardiac arrest developed. Shortly after the administration of 25 ml of 8.5% calcium gluconate, closed chest cardiac compression was successful to restore a sinus rhythm. Ninety minutes after the induction, he was transferred to the Intensive Care Unit. Vital signs became stable and electrocardiogram showed normal sinus rhythm. The serum potassium level decreased to normal range in 2 hr. During subsequent hours, the muscle contracture gradually subsided. Physical examination revealed no neurologic defects, but the patient suffered from swelling and pain of the thighs.

Two days later, whole-body scintigraphy was performed 3 hr after i.v. injection of 20 mCi (740 MBq) of [^{99m}Tc]PYP. Abnormal uptake was observed in the skeletal muscles of both thighs, arms and chest, and the right tibia, but no abnormal myocardial uptake was obtained (Fig. 1). Echocardiography revealed a normal-size of left ventricle with normal wall motion. There was no sign of valvular abnormalities. Serum creatine phosphokinase (CPK) (normal range 30–140 IU) and lactate dehydrogenase (LDH) (50–400 U) were determined every day. The highest values (345,400 IU of CPK and 22,420 U of LDH) were obtained on the next day of crisis, and they returned to normal range in 2 wk. Isozyme levels over 98% of CPK and 58% of LDH were CPK-MM and LDH_5, which were derived from skeletal muscle. CPK-MB and LDH_1, which were useful in assessing myocardial destruction, were negligible. The follow-up scintigram obtained 4 months after the first scan demonstrated the absence of abnormal uptake by both the skeletal muscles and myocardium.

An impaired regulation of intracellular calcium ion concentration of skeletal muscle has been postulated as the pathogenesis of MH. The clinical manifestations of acute crisis consist of skeletal muscle contracture of various degrees, hyperthermia, and severe metabolic and respiratory acidosis, which are secondary to the skeletal muscle hypermetabolism due to the elevation of intracellular calcium level (*1*,*2*). The mechanism of tachyarrhythmia, the initial clinical sign of this syndrome,

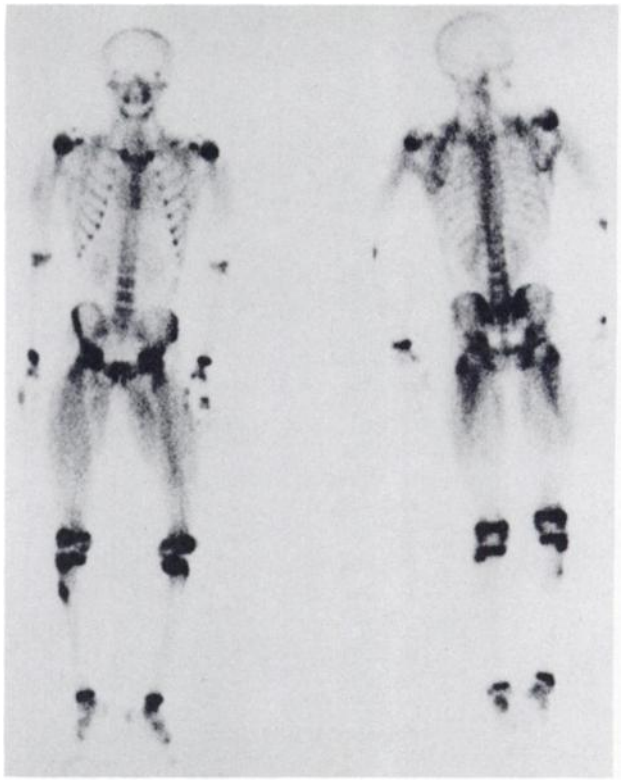

FIGURE 1
Anterior (left) and posterior (right) view of whole-body scintigram using [^{99m}Tc]pyrophosphate. Abnormal uptake was observed on the skeletal muscles of both thighs, arms, and chest, and the right tibia, but no myocardial uptake was observed. Generalized skeletal muscle destruction was suggested without any myocardial involvement. Accumulation in the right tibia indicate the presence of bone tumor.

has not fully been elucidated. It may be either the hyperdynamism secondary to the hypermetabolism of total body skeletal muscle or the direct involvement of myocardium. The direct involvement of cardiac muscle has been suspected with microscopic observation at necropsy (*3*) and thallium-201 myocardial scan (*4*). In contrast, absence of myocardial involvement has been reported with the histologic examination at endomyocardial biopsy (*5*).

The uptake of [^{99m}Tc]PYP employed in the present study is limited to the necrotic and severely injured cells (*7,8*) and a positive accumulation is demonstrated 12 hr to 6 days after the muscle injury (*6*). Kawamoto et al. (*9*), using [^{99m}Tc]PYP scintigraphy, demonstrated absence of myocardial involvement following recovery from MH crisis. Their report was, however, not conclusive to rule out the myocardial involvement, since their patient did not develop either cardiac arrest nor severe cardiac dysfunctions during the crisis. To our knowledge, our report is the first to demonstrate that the myocardium is not involved by the pathogenesis of MH. It is thus strongly suggested that the severe and sometimes fatal cardiac dysfunctions occurring during the hyperthermic crisis are secondary to either or both the cardiac hyperdynamism due to the elevated skeletal muscle metabolism and hyperkalemia secondary to the muscular destruction. The prompt restoration of sinus rhythm following intravenous administration of calcium gluconate observed in the present patient support this postulate.

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Dynamic Xenon-133 SPECT in Dementia

TO THE EDITOR: In the paper "Assessment of Demented Patients by Dynamic SPECT of Inhaled Xe-133" (*J Nucl Med* 1988; 29:1621–1626), the authors report their experience with the evaluation of regional cerebral blood flow (rCBF) employing single photon emission tomographic (SPECT) determination using inhaled xenon-133 (^{133}Xe) in a group of patients with Alzheimer's disease (AD), senile dementia of the Alzheimer type (SDAT), multi-infarct dementia, as well as in a group of elderly control subjects. This is an interesting work, but it contains two significant errors:

1. In our own experience with inhaled [^{133}Xe]SPECT (*1–4*) we have found that the pattern of flow reduction in the posterior temporal and parietal regions may be symmetrical in patients with early or moderately advanced AD or SDAT, but it is quite commonly asymmetrical, with significant differences in relative posterior flow reduction. Further, left or right frontal flow reduction may occur in a smaller number of patients. There is a tendency for flow reduction to match general clinical symptoms, with left posterior rCBF deficits accompanying short-term memory problems, right posterior deficits accompanying spatial orientation difficulties, left frontal flow deficits in patients with aphasia, etc. These asymmetries have also been identified by investigators using other SPECT techniques (*5*).

2. The authors are not the first to report experience with ^{133}Xe inhalation SPECT in the entities under study. We, and our colleagues, have described our own experience in a similar group of patients in three abstracts (*1–3*), and one peer-reviewed paper (*4*), all published in universally available journals.

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REPLY: We address the points in the letter by Bonte and Devous below.

1. Patients with dementia employed in our study were early stage and could not receive an examination of Hasegawa's