Technetium-99m Stannous Pyrophosphate Myocardial Scintigraphy after Cardiopulmonary Resuscitation with Cardioversion

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SUMMARY Thirty consecutive patients underwent technetium-99m stannous pyrophosphate myocardial scintigraphy 48–72 hours after successful cardiopulmonary resuscitation and direct current cardioversion. Five patients with transmural myocardial infarctions by ECG and enzyme determinations were correctly identified by scintigraphy. Myocardial scans were positive in five of nine patients with nontransmural infarction. Of 16 patients without evidence of myocardial infarction, only two (13%) had false-positive myocardial scans. The overall accuracy of imaging in this series was 80%. We conclude that false-positive scans after cardiopulmonary resuscitation with electrical cardioversion are infrequent, and do not significantly detract from the value of myocardial scintigraphy in the diagnosis of myocardial infarction.

THE ROLE of myocardial imaging with technetium-99m stannous pyrophosphate (\textsuperscript{99m}Tc-PYP) in the diagnosis of acute myocardial infarction has not been precisely defined.\textsuperscript{1,2} Many reports of positive myocardial scintigrams in patients without clinical evidence of acute infarction have been published. DC countershock is often cited as a cause of false-positive myocardial scintigrams.\textsuperscript{3-5} This study reports our experience with 30 consecutive patients who underwent \textsuperscript{99m}Tc-PYP myocardial imaging after cardiopulmonary resuscitation (CPR) and DC cardioversion. The effects of resuscitation procedures on the accuracy with which subsequent \textsuperscript{99m}Tc-PYP scans correctly identify the presence of an acute myocardial infarction are discussed.

Materials and Methods

All patients reported in this study were admitted to the medical intensive care area at Northwestern Memorial Hospital. Each patient had undergone successful CPR, including external cardiac massage and DC cardioversion. Serial ECG, and serum enzymes, including assays of lactic dehydrogenase (LDH) and creatine kinase (CK) isoenzymes, were obtained.* The criteria for the diagnosis of acute myocardial infarction included a twofold elevation of the serum enzymes above normal, associated with either an elevated CK-MB fraction or a LDH\textsubscript{1}-LDH\textsubscript{2} ratio ≥ 1. A pattern in the rise and fall of the individual

*CK isoenzymes were separated by electrophoresis in agarose gel. After incubation with a substrate solution, CK isoenzyme activity was quantitated with a fluorometric densitometer.

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**Results**

Studies in 30 consecutive patients form the basis of this report. The pertinent clinical data and the results of laboratory investigations are summarized in Table 1.

**True-positive Scans**

In all five patients diagnosed as having a transmural myocardial infarction, myocardial images were abnormal and consistent with this diagnosis. One of these patients died 12 days after CPR, and at autopsy showed a transmural myocardial infarction that was approximately 2 weeks old.

Five of the nine patients with nontransmural myocardial infarctions had myocardial uptake of $^{99m}$Tc-PYP.

**True-negative Scans**

Myocardial uptake of $^{99m}$Tc-PYP was absent in 12 patients who had no evidence of myocardial infarction after resuscitation. Two other patients with isolated elevations of the serum CK-MB fraction, but without other significant enzyme abnormality or electrocardiographic change, had negative scans. Three of these patients died (5, 6 and 12 days after CPR), and pathological examination corroborated the absence of myocardial necrosis. This group includes the person who was given the largest total energy dose in the series (2200 J).

**False-negative Scans**

Four of the patients who met enzymatic and ECG
criteria for nontransmural infarction had negative myocardial scintigrams.

False-positive Scans

Abnormal uptake of $^{99m}$Tc-PYP was shown in two patients who had no other evidence of acute myocardial infarction. Autopsy examination of one of the two patients, who died 8 days after CPR, showed cardiomegaly with biventricular hypertrophy, but no evidence of myocardial necrosis. Anterior and 60° left anterior oblique views of the chest obtained in the other patient are shown in Figure 1. We could not identify any characteristic peculiar to these patients that might explain the false-positive scintigraphy.

Discussion

Acute myocardial infarction must almost always be considered in the differential diagnosis of the patient who successfully undergoes CPR and cardioversion. Yet, in this clinical setting, the traditional pattern of change in the serum enzymes is frequently obscured by the release of enzymes from other tissues made ischemic or injured as a result of the resuscitation. Atypical electrocardiographic changes, or those distorted by an intraventricular conduction disturbance, can pose a diagnostic dilemma. Although the investigation of the CK-MB fraction has contributed greatly to the more accurate determination of myocardial necrosis, false-positive elevations have been reported after cardioversion and cardiac trauma suffered during resuscitation.10–12 Myocardial scintigraphy with $^{99m}$Tc-PYP appeared to be a promising technique that might be useful in evaluating patients for acute infarction after resuscitation. It was therefore discouraging when isolated case reports and studies of experimental animals13, 14 apparently indicated that DC cardioversion could result in a significant instance of positive myocardial scans in the absence of ischemic heart disease. Recently published clinical series offer conflicting results. In one study of 28 patients who had negative myocardial scans before elective DC cardioversion for atrial fibrillation, twelve (48%) developed a positive scan after the procedure.15 However, another study which dealt primarily with elective cardioversion and direct epicardial defibrillation during cardiac surgery, reported that none of the patients without coronary heart disease developed positive uptake of $^{99m}$Tc-PYP.16 The 30 patients in the present study were subjected to DC countershock (often repetitive and at a high energy setting), as well as CPR. External cardiac massage can produce myocardial contusion, a condition that has been shown both experimentally and clinically to result in positive myocardial scans.16, 17 Yet of 16 patients without evidence of myocardial infarction, only two (13%) had false-positive $^{99m}$Tc-PYP scintigrams. All transmural infarctions were correctly identified. Since none of the patients assumed to have suffered nontransmural infarction died, pathological confirmation of this clinical entity is unavailable. Nevertheless, the prevalence of positive myocardial scintigrams was comparable to that described in the literature.18 Although in several cases increased focal uptake of the radio-pharmaceutical was noted in the region of bony structures in the chest, the interpretation of the myocardial scintigram was obscured in only one patient by the possible accumulation of $^{99m}$Tc-PYP in chest wall skeletal muscle.19 The overall accuracy of imaging in this series was 80%.

Our data suggest that false-positive images after CPR with DC countershock are infrequent and do not represent a major source of error in the interpretation of $^{99m}$Tc-PYP myocardial scintigrams. It is now well-documented that most “sudden death” episodes are not precipitated by an acute myocardial infarction.20 We have found that $^{99m}$Tc-PYP myocardial scintigraphy is a reliable tool for the diagnosis of myocardial infarction in patients who have undergone out-of-the-hospital CPR.

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References


**Figure 1.** Anterior (A) and 60° left anterior oblique (B) views of the chest: there is diffuse increased uptake to the left of the sternum, which may represent uptake in the chest wall secondary to defibrillation, although the possibility of myocardial damage cannot be excluded. There was no electrocardiographic or enzymatic evidence of acute myocardial infarction.
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