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RADIONUCLIDE IMAGING OF EXPERIMENTAL MYOCARDIAL CONTUSION

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Localization of ^{99m}Tc-Sn-polyphosphate in injured myocardium following experimental myocardial contusion in dogs has been demonstrated. Imaging using this radiopharmaceutical agent to detect areas of myocardial damage should be a useful technique in clarifying the difficult clinical diagnosis of myocardial contusion following closed chest trauma in man.

Myocardial contusion is a clinical diagnosis and changes in EKG and serum enzymes are often nonspecific (*1*). In order to obtain a more accurate method of diagnosis of cardiac injury associated with closed chest trauma, ^{99m}Tc-Sn-polyphosphate (*2*) was studied to image experimental myocardial contusion in dogs following the report of its use for imaging myocardial infarction (*3*).

MATERIALS AND METHODS

Studies were done in five mongrel dogs weighing from 18–22 kg. All studies were conducted under general intravenous pentobarbital anesthesia. A Searle Radiographics Pho/Gamma III scintillation camera was used for imaging.

Each dog was given an intravenous injection of 5 mCi of ^{99m}Tc-Sn-polyphosphate. Control images of the chest in the anterior, oblique, and left lateral projections were made 1–2 hr after the administration of the radiopharmaceutical agent. After completion of imaging, each dog was returned to the animal house. Myocardial contusion was induced about 24 hr after the initial control studies. This was accomplished by impact of a captive bolt handgun to the intact chest wall. One to 3 hr after contusion, 5 mCi of ^{99m}Tc-Sn-polyphosphate were administered intravenously; imaging of the chest was started 1–2 hr later with the same projections as the control studies. One dog was sacrificed 3 hr following contusion after the initial scintiphotos were accomplished. Gross pathologic examination and tissue-distribution studies were carried out. Followup scanning was attempted but only one dog survived to allow followup scanning up to the eighth day following contusion. One died before administration of the repeat tracer dose for the 24-hr scanning; another died a few minutes after administration of the tracer for the 48-hr scanning so that attempted scanning showed only blood pool activity; the last died after the 48-hr followup scanning was completed. Deaths were due to a combination of pentobarbital anesthesia and low cardiac output. All dogs were autopsied and gross pathologic examinations carried out. The last dog had tissue-distribution study 48 hr after contusion. Samples for distribution studies were obtained from both injured and normal skeletal muscles, bone, lung, myocardium, and liver. Blood sample was also obtained. The tissue samples were weighed and assayed for radioactivity in a well scintillation counter.

RESULTS AND DISCUSSION

Scintiphotos of the dogs taken before contusion showed normal localization of radionuclide in the skeleton with no activity in the heart area (Fig. 1A). After contusion, the scintiphotos showed an abnormal area of increased activity in the region of the heart (Fig. 1B). Gross pathologic examination showed that the area of myocardial injury (Fig. 1C) corresponds to the area of increased activity in the scintiphoto. The tissue-distribution studies performed on two dogs show an injured-to-normal myocardium ratio of 14:1 and 4:1 (Table 1).

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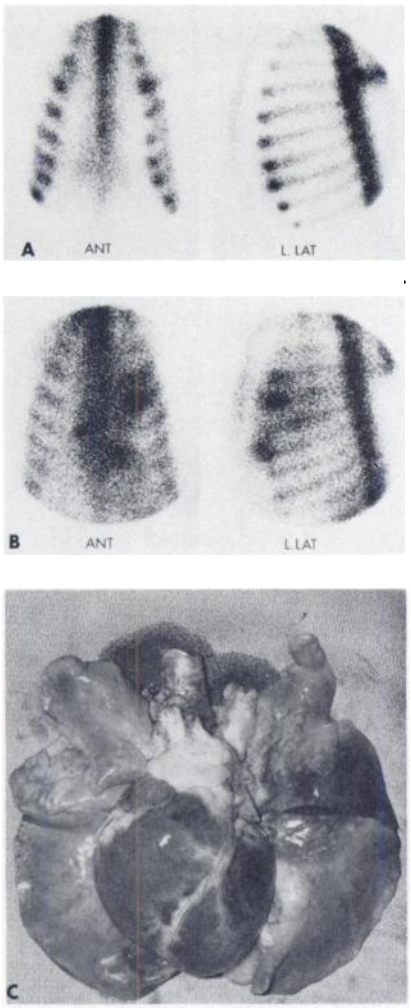

FIG. 1. (A) Control: scintiphotos of chest in anterior and left lateral views showing normal localization of radionuclide in skeleton with no activity at region of heart. (B) After contusions: scintiphotos done 2 hr after contusion (1 hr after administration of radionuclide) show abnormal area of increased activity at region of heart. Increased activity below heart is injured liver. (C) Gross pathologic findings: shows area of myocardial injury corresponding to abnormal area of increased activity in scintiphotos.

The area of myocardial injury could be detected by this imaging technique as early as 2–3 hr after contusion in all dogs. Localization of radionuclide tracer persisted up to 48 hr in three and up to 96 hr in one; this was negative at the eighth day.

Correlating the findings of the scintiphotos with the gross pathologic findings, tissue-distribution studies, and the fact that tracer localization disappeared with time in one dog suggests that the degree of activity and detectability of myocardial contusion is related to the extent, severity and duration, or "freshness," of the injury.

The mechanism of localization of ^{99m}Tc-Sn-polyphosphate in myocardial contusion is probably similar to that in myocardial infarction as suggested by Bonte, et al (*3*). Most probably myocardial cell death resulting from contusion is also followed by cellular influx of calcium ions, which localize within the mitrochondria in the crystalline structure hydroxyapatite to allow imaging by the apatite-labeling radionuclide tracer.

TABLE 1. TISSUE DISTRIBUTION OF ^{99m}Tc-Sn-POLYPHOSPHATE SHOWING RATIO OF ACTIVITY PER GRAM OF DIFFERENT TISSUES AS COMPARED WITH ACTIVITY PER GRAM OF NORMAL MYOCARDIUM

Tissues		Dog A (3 hr after contusion)	Dog B (48 hr after contusion)
Skeletal muscle	Normal	0.4	0.6
	Injured	1.5	1.6
Bone	Normal	8.2	16.0
	Injured*	4.1	14.8
Lung	Normal	1.8	no sample
	Injured	4.1	1.2
Myocardium	Normal	1.0	1.0
	Injured	14.0	4.5
Liver	Normal	1.0	1.7
	Injured	7.6	no injury
Blood	——	2.1	2.3

* Dog A's sample had bone and cartilage.

The study shows good localization of ^{99m}Tc-Sn-polyphosphate in experimental myocardial contusion. Myocardial contusion in man, which at present does not have a good confirmatory test, may be diagnosed by this radionuclide imaging technique. This will have its best clinical application in the diagnosis of myocardial contusion in man following the familiar civilian car accident when the chest is crushed against the steering wheel. The test can be done without danger or discomfort to the critically ill patient. This method is presently undergoing clinical evaluation in our institution.

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