NMT Gadgetry

Inexpensive Rib Phantom for Myocardial Infarct Scintigraphy

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A rib phantom is constructed from polyvinyl irrigation pipes to simulate rib activity in myocardial infarct scintigraphy using ^{99m}Tc-pyrophosphate. It is useful to evaluate the effects of radionuclide concentrations and locations of the myocardial infarct in relation to the detectability of the lesion.

Direct visualization of acute myocardial infarcts by radionuclide imaging technique utilizing pyrophosphate was pioneered by Bonte et al. *(1,2)* and Parkey et al. *(3)*. Detectability depends on the relative concentration of ^{99m}Tc-pyrophosphate in the damaged myocardium. As ^{99m}Tc-pyrophosphate is also a bone-seeking agent, it will localize in the sternum and thoracic cage. Thus it becomes important to know what effect this has on the detectability of an underlying lesion in the heart. This may be done with a simple rib phantom constructed from polyvinyl irrigation pipes.

Materials and Methods

The ribs are simulated with 0.5-in.-diam polyvinyl irrigation pipes sealed on one side by plastic caps (Cohartnes, Taiwan) using polyvinyl adhesives. The other ends of the pipes are connected to plastic cross connectors (Cohartnes, Taiwan) which represent the sternum. The plastic caps on the right side of the simulated sternum are sealed with petroleum wax alone and are therefore removable to allow introduction or removal of the radioactive material. The heart phantom consists of a 400-ml plastic beaker in which is placed a 6-ml ^{99m}Tc-eluate collection vial (New England Nuclear, MA) containing either 5 or 2 ml of radioactive material to simulate an acute myocardial infarct. The inner diameters of the beaker and collection vial are 8 and 1.8 cm, respectively (Fig. 1).

Approximately 4 mCi of ^{99m}Tc-pertechnetate is diluted with 500 ml of tap water and 400 ml of this is used to fill the rib phantom. Sixty milliliters of the remaining ^{99m}Tc-pertechnetate solution is diluted with tap water to 300 ml for the heart phantom. The ratio of radioactivity between the ribs and the heart is 5:1. Medium and small infarcts were simulated by adding 5 or 2 ml of ^{99m}Tc-pertechnetate solution into the 6-ml collection vial. The concentration of radioactivity in the vial was varied during the phantom study so that the infarct-to-rib ratios were 0.5:1, 1:1, 1.5:1, and 2.5:1. Scintigrams were recorded on Polaroid film from a General Electric Radicamera II scintillation camera with a low-energy high-resolution parallel-hole collimator using a present count of 300k. Each vial was imaged in the anterior, lateral, and posterior aspects of the heart phantom either in between the ribs or completely behind the ribs. The visibility of the infarcts on the scintigrams was graded as excellent (4+), good (3+), fair (2+), faint (1+), and not visible (0).

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Results

The visibility of the 5- (Fig. 2) and 2-ml (Fig. 3) infarcts in various locations is tabulated in Tables 1 and 2, respectively. The infarcts were better delineated when positioned in a rib space rather than when they were behind a rib and were better visualized in the anterior position close to the ribs compared to the lateral and posterior positions at some distances behind the ribs.

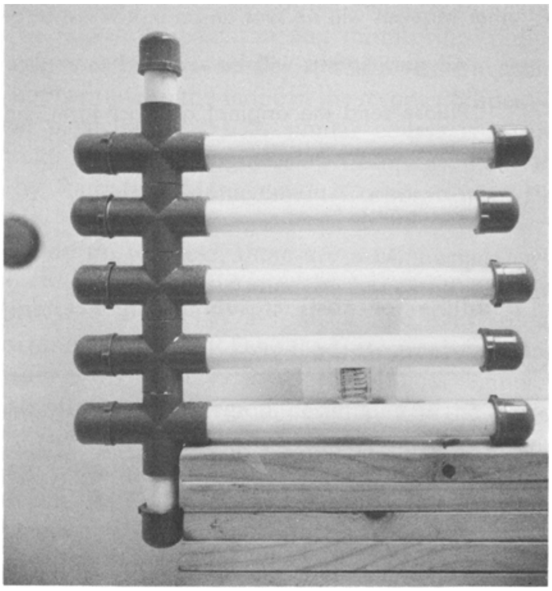

FIG. 1. Rib and heart phantom.

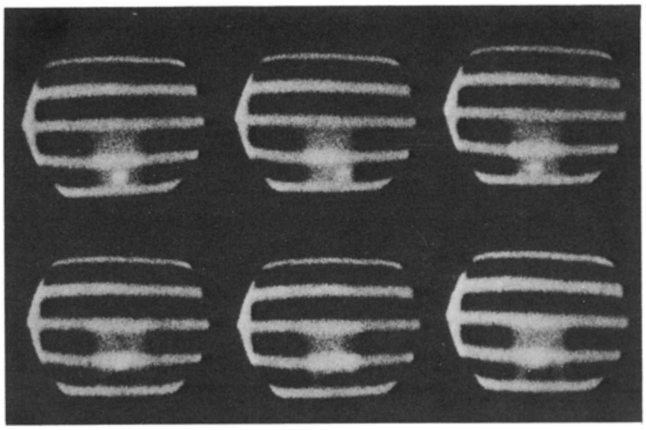

FIG. 2. Scintigrams of rib and heart phantom with 5-ml infarct located in rib space (top) and behind rib (bottom), and in anterior, lateral, and posterior (left to right) aspects of heart. Infarct-to-rib radionuclide ratio is 1.5:1.

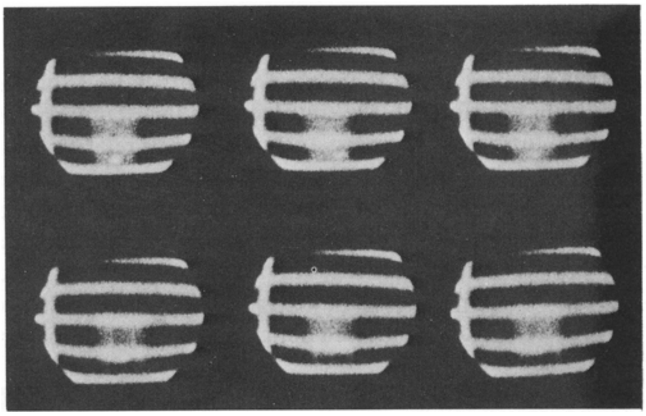

FIG. 3. Scintigrams of rib and heart phantom with 2-ml infarct located in rib space (top) and behind rib (bottom), and in anterior, lateral, and posterior (left to right) aspects of heart. Infarct-to-rib radionuclide ratio is 1.5:1.

Discussion

The phantom study has provided useful information on the detectability of lesions in acute infarct scintigraphy. The size and concentration of radioactivity in the infarcts along with their location appear to be the major factors in their detection by scintigraphy. The study shows that an infarct of 5 ml with radioactivity equal to or higher than bone should be easily detected especially when it is anteriorly located in a rib space, whereas a smaller infarct of 2 ml would enable good detection only if it concentrates at least 1.5 times more radioactivity than the ribs. The rib and heart phantom is inexpensive (less than $10), easy to construct, and is helpful in developing and refining techniques for imaging acute myocardial infarcts. It is also useful for teaching purposes, for quality control, and for the evaluation of performances of different scintillation camera systems.

TABLE 1. Visibility of 5-ml Cylindrical Infarct (18 × 18 × 20 mm) According to Radionuclide Concentration and Position

	Anterior				Lateral				Posterior			
Infarct/rib ratio	0.5	1.0	1.5	2.5	0.5	1.0	1.5	2.5	0.5	1.0	1.5	2.5
Infarct in rib space	0	3+	4+	4+	0	2+	3+	4+	0	2+	3+	3+
Infarct behind rib	0	2+	2+	3+	0	0	1+	2+	0	0	1+	2+

TABLE 2. Visibility of 2-ml Cylindrical Infarct (18 × 18 × 8 mm) According to Radionuclide Concentration and Position

	Anterior				Lateral				Posterior			
Infarct/rib ratio	0.5	1.0	1.5	2.5	0.5	1.0	1.5	2.5	0.5	1.0	1.5	2.5
Infarct in rib space	0	1+	3+	4+	0	0	2+	2+	0	0	2+	2+
Infarct behind rib	0	0	1+	2+	0	0	0	1+	0	0	0	1+

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