Case Reports

Underestimation of equilibrium radionuclide left ventricular ejection fraction due to myocardial uptake of $^{99m}$Tc

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Abstract. First pass and gated equilibrium radionuclide imaging (in vitro labelling) was performed on three occasions (on day 1, 1 week and 4 weeks later) in a patient, who had suffered from myocardial infarction 6 months previously. At the 1 week assessment four successive equilibrium blood pool scans were performed within an hour. The patient was in a stable clinical condition, and the following values were obtained for right (RVEF) and left ventricular ejection fraction (LVEF): 0.66, 0.64 and 0.68; LVEF: 0.30, 0.29 and 0.30, respectively. Corresponding values for global LVEF determined by equilibrium imaging were: day 1 0.24, 1 week 0.16, 0.15, 0.13 and 0.14, 4 weeks 0.26. Underestimation of the LVEF by the gated equilibrium method at the 1-week assessment was probably due to myocardial uptake of non-RBC bound $^{99m}$Tc in an apical aneurysm as later confirmed by a positive myocardial scan with $^{99m}$Tc-stannous pyrophosphate.

With the extensive clinical use of radionuclide cardiography in measuring the ejection fraction and other variables of heart performance, it has become increasingly important to be familiar with advantages and disadvantages of these methods. We report what we believe is a hitherto unnoticed cause of underestimation of left ventricular ejection fraction by the multigated equilibrium technique: myocardial uptake of non-erythocyte bound $^{99m}$Tc in a patient with a left ventricular aneurysm.

Case report

A 59-year-old woman gave informed consent to participate in a clinical investigation, the aim of which was to determine reproducibility of left (LVEF) and right ventricular ejection fraction (RVEF) and other variables obtained by both first pass and gated equilibrium radionuclide cardiography. Six months previously she had had an acute myocardial infarction, but now she was in a stable clinical condition receiving no medication. The chest X-ray film showed cardiomegaly with enlargement of predominantly the left ventricle. The ECG showed QS-pattern and ST-segment elevation in $V_{1-3}$, and left ventricular hypertrophy with negative T-waves in $V_{4-6}$.

According to the protocol of the reproducibility study radionuclide investigations were performed on three occasions at the same time of the day: on day 1, 1 week and 4 weeks later. In each patient computer analysis of all studies was done at completion of the final assessment. On all of the three occasions an initial first pass study in the 30° RAO view was followed by gated equilibrium imaging in an optimal LAO view collecting 5 million counts. In all studies the patients' erythrocytes were labelled in vitro with stannopyrophosphate and 30 mCi $^{99m}$Tc-pertechnetate [2]. At either day 1 or at the 1-week assessment four LAO scans were performed within an hour, each starting every 15 min. In our patient this was done at the 1-week assessment.

On the three occasions first pass RVEF was 0.66, 0.64 and 0.68 and first pass LVEF 0.30, 0.29 and 0.30, respectively. Corresponding values for the global LVEF determined by gated equilibrium imaging were: day 1 0.24, 1-week 0.16, 0.15, 0.13, 0.14, 4-weeks 0.26. Labelling was successful (as judged from the percentage of the total activity found prior to injection in the erythrocyte fraction of a haemotocrit tube) at day 1 (98%) and the 4-week assessment (99%) and less successful (75%) at the 1-week assessment. This difference was also clearly visible on the LAO images (Fig. 1). The low labelling percentage was probably due to the use of the first-day eluate from a new generator [2]. On all occasions phase analyses showed an apical left ventricular aneurysm with paradoxical movement, and the ejection fraction in the remaining part of the ventricle was 0.34, 0.36 and 0.37, respectively (Fig. 2).

The images obtained at the 1-week assessment displayed an extra accumulation of activity in the apical region of the left ventricle compared with images from the day 1 and the 4-week assessment (Fig. 1). This extra accumulation of activity seemed to extend a little below the outline of the left ventricular cavity and also to stretch into the inferior wall of the right ventricle (Fig. 1), indicating myocardial accumulation. To verify this finding, a conventional myocardial scintigraphy with 15 mCi $^{99m}$Tc-stannous pyrophosphate (Tc-PYP) was performed 2 months later. The scintograms showed pathological accumulation of activity in the infero-apical region of the myocardial wall (Fig. 3).

Discussion

Tc-PYP may accumulate in dyskinetic or akinetic areas of the left ventricle [1, 5], possibly due to ongoing cellular
Fig. 1. Gated equilibrium images of the heart in diastole obtained (from left to right) on day 1, 1 week and 4 weeks later. Note low background activity in the first and the third image, compared with the high background in the 1 week image. Note also in the 1-week study accumulation of activity in the liver and the gastric wall and additional accumulation of activity in the apical region of the left ventricle stretching inferiorly towards the right ventricle.

Fig. 2. Phase-analysis pictures (same sequence as in Fig. 1). Note paradoxical movement in the apical region on all three occasions. Ejection fractions in the remaining part of the left ventricle (within the regions of interest) were 0.34, 0.36 and 0.37, respectively.

Fig. 3. Myocardial scintigrams obtained (from left to right) in the antero-posterior view, two left anterior oblique views and the left lateral view.

damage in chronically ischaemic myocardium [4, 8]. This is a common cause of false-positive myocardial scintigrams in the diagnosis of acute myocardial infarction. It is well known that myocardial uptake of Tc-PYP may be present for weeks or months in a substantial percentage of patients who have had a myocardial infarction [3, 4, 6, 7].

It is probably less well known that in such patients unsuccessful labelling of red blood cells may result in myocardial uptake of non-RBC bound Tc-PYP, which in turn may lead to underestimation of LVEF determined by the gated equilibrium technique. This process seemed to be the explanation for the low LVEF value found at the 1-week assessment on a day with poor RBC-labelling. Localised within the left ventricular region of interest (in the LAO view) this extra accumulation of activity added substantially to the activity in both end diastole and end systole, rendering the multigated LVEF erroneously low on calculation. The first pass studies (performed on all occasions) showed no change and aroused the suspicion that a technical error had occurred in the multigated 1-week studies, rather than a change in heart function.

It thus seems advisable whenever possible to do both a first pass and an equilibrium study in the same patient so that unexpected discrepancies can be clarified and corrected. In patients with wall motion abnormalities due to acute or previous myocardial infarction the possibility of myocardial uptake of Tc-PYP should always be considered, especially when RBC-labelling is poor.