Nuclear medicine 3: myocardial perfusion imaging

Myocardial perfusion imaging (MPI) is the assessment of blood perfusion of the cardiac muscle (defined in Box 1) with the help of a radioactive drug, also known as a radiopharmaceutical. It is used to assess cardiac viability and diagnose myocardial ischaemia or infarction, which may result from a partially or fully occluded coronary artery (Sharp et al, 2005).

How does MPI work?
A radiopharmaceutical – commonly, technetium-99m sestamibi (defined in Box 1) – is administered intravenously to the patient and travels through the body via the blood circulation. When it arrives at the heart, it leaks from the capillaries through the cell membranes into cardiac myocytes (defined in Box 1). Once inside the myocyte, the radiopharmaceutical is trapped by mitochondria (defined in Box 1), provided these are intact. This trapping is a sign that there is coronary circulation into a viable myocyte. The distribution of the drug in the cardiac muscle is observed with a gamma camera, which will show the areas where the drug has been trapped. This is how myocardial perfusion (defined in Box 1) is assessed (Technescan, 2014).

MPI is often performed in two parts:
- Part 1: to observe the heart in a period of stress (for that investigation the patient’s heart rate is increased by physical activity or the administration of a drug simulating physical activity);
- Part 2: to observe the heart in a normal resting state.

The acquired images of the patient’s heart under ‘stress’ and ‘rest’ conditions are then compared. If a segment of cardiac muscle is more intense/brighter on the MPI image at rest than under stress, it indicates a mismatch between oxygen supply and demand, which is suggestive of reversible ischaemia. This occurs when the heart is working harder than normal. Fig 1 shows irreversible ischaemia in the anterolateral segments.

When assessing cardiac viability, only ‘rest’ images are required. In these images, dark areas suggest dead myocytes. If a blood test for circulating troponin is to be performed after an MPI scan has revealed signs of ischaemia, health professionals need to bear in mind that sensitive assays may detect an increase in circulating troponin after MPI (Sabatine et al, 2009). The MPI can cause areas of the heart to become ischaemic, resulting in the

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Key points
Myocardial perfusion imaging (MPI) assesses blood perfusion of the cardiac muscle
An MPI scan of the heart at rest allows assessment of cardiac viability
Comparing MPI images of the heart under ‘stress’ and ‘rest’ conditions allows detection of reversible ischaemia
Sample collection is best avoided in the first 24 hours after an MPI scan
MPI is often called a cardiac stress test, but avoiding use of that term may help to alleviate patients’ anxieties

Authors
Joseph Purden and Faye Morton are lecturers in medical physics technology, College of Human and Health Sciences, Swansea University.

Abstract
Nuclear medicine provides imaging modalities that can be used to observe physiological processes in the human body, particularly in the bones, heart, lungs, renal system and brain. This article – the third in a five-part series – explains how myocardial perfusion imaging works and what precautions need to be taken with, and around, patients undergoing the procedure.

Citation
increase in circulating troponin. In rare cases, this increase could be mistaken for an unknown previous cardiac event.

In general, injections are administered 30-60 minutes before scanning to allow time for the radiopharmaceutical to clear from the liver and gastrointestinal system. If it does not clear, the view of the left ventricular inferior wall can be obscured. The imaging itself takes around 20 minutes.

Preparing patients
Patients who are about to undergo MPI usually have to go to the nuclear medicine department. If they have reduced mobility, it is useful to inform the nuclear medicine department ahead of time, to ensure the correct protocols are used when imaging is carried out.

It is common practice for a cardiac physiologist, or other cardiology expert, to be present when the radiopharmaceutical is administered to monitor the patient’s electrocardiogram and blood pressure.

A cannula is usually inserted before the procedure. The radiopharmaceutical will be administered through it, as will the drug to simulate exercise and increase heart rate if needed. The cannula will be removed at the end of the investigation; it must be carefully disposed of as it will have become radioactive.

In cases of severe urinary incontinence, it is advised that the patient has a catheter in situ for the duration of the procedure to avoid contamination of the camera by spills of radioactive urine. The catheter bag should be emptied regularly to prevent an accumulation of radioactive urine.

Alleviating patients’ anxieties
Colloquially, MPI is often referred to as a cardiac stress test. As a result, patients often have many questions about the safety of the investigation and may arrive for it feeling very anxious. In some cases, they may even refuse to have the MPI scan. To mitigate against this, nurses may want to consider avoiding use of the term ‘cardiac stress test’ when explaining the procedure to patients (Prakash, 2014).

Radiation protection
Patients should be encouraged to drink and urinate often, unless this has been contraindicated. This will help to clear the radiopharmaceutical from their system.

If samples of blood, urine or faeces need to be collected from patients in the 24 hours after an MPI scan, nurses should take extra care:
- Wear gloves, an apron and shoe coverings;
- Use absorbent pads to clean up any spillages.

If possible, it is advisable to either perform sample collection before the injection of the radioactive drug or postpone it until after 24 hours have passed since the investigation was undertaken.

Patients should not be in close contact with young children or women who are pregnant (the two groups most at risk from exposure to radiation) for the first 24 hours after the radiopharmaceutical has been administered. Ideally, members of staff who are pregnant should not care for patients who have just had an MPI scan, and all staff need to take extra care to reduce their own exposure to radiation. After 24 hours, normal staff rotas and standard care protocols can be resumed. NT

References

Box 1. Glossary
- Blood perfusion: passage of blood through the circulatory system into an organ or a tissue
- Cardiac muscle: involuntary, striated muscle constituting the main tissue of the walls of the heart – also called heart muscle or myocardium
- Mitochondria: organelles within cells that produce energy by oxidising fats and sugars
- Myocardial perfusion: passage of blood through the circulatory system into the cardiac muscle
- Myocyte: cells that form muscle tissue
- Technetium-99m sestamibi: radiopharmaceutical agent comprising the radioisotope technetium-99m (see part 1) bound to six (sesta=6) methoxyisobutylisonitrile (MIBI) ligands

Fig 1. Myocardial perfusion imaging: irreversible ischaemia

Absent/reduced counts in anteroapical segments, including apex and inferior apical segments. Shows full-thickness infarction. No reversible ischaemia, evidence of myocardial infarction.

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