BONE SCINTIGRAPHY

Peter Valk

Bone scintigraphy is actually better known as bone scanning. It occurred to me that it might be an interesting topic to discuss at a SPUMS meeting. I discovered, with quite some surprise, last year that Australian professional divers are required by regulation to have annual X-rays of their long bones. Annual seems a bit frequent. If you are going to look for bone necrosis X-rays are not ideal. Those of us who have been working with general medical and surgical patients in hospital know that when looking for bone necrosis in other conditions scintigraphy is much more sensitive and picks up lesions much earlier than X-rays.

Bone scintigraphy is basically the injection of a radioactive substance, a radiopharmaceutical, intravenously and then, at various times after the injection, a gamma camera is used to collect data which gives a two dimensional display of radioactivity. In the case of bone scintigraphy this is a picture of the skeleton. The radiopharmaceutical now used for bone imaging is one form or another of a Technetium 99 m phosphate complex and various phosphates have been used. When these compounds are circulating through bone they are absorbed through the bone surface, particularly if it is recently mineralised or mineralising bone, and to a lesser extent there is actual binding of the phosphate to calcium in hydroxyapatite. That is the mechanism by which the radiopharmaceuticals stick to the bone. What determines how much is going to end up in a particular area of bone is the functional status of that bone.

That is one thing that makes scintigraphy significantly different from radiography. Radiography looks at shadows cast by different amounts of calcium that happen to be present. What can be seen with scintigraphy is two things. One is the blood flow to the bone, because obviously a piece of bone cannot take any up unless the radiopharmaceutical gets there via the blood stream. Secondly, the level of osteoblastic activity. This will determine what fraction of the radioactivity that goes through the bone will be fixed and what fraction will move on. Obviously a decrease in either of these factors can lead to decreased and finally absent up-take. As far as any increase is concerned, the most important factor is bone blood flow because this can be increased up to 20 or 30 times, whereas with normal bone extraction efficiency is about 50%. So there will only be a 2 to 1 increase in uptake by an increase in osteoblastic activity.

Having discussed how this tracer binds to bone, let us look at what happens in a case of avascular necrosis. First the blood supply to the marrow in the bone is cut off, and instantly there is an absence of up-take of tracer in that part of the bone. Within 24 hours the marrow dies and then gradually over a couple of weeks the osteoblasts of the bone die. At any time during this period bone scintigraphy shows a cold area where the infarct is located. Subsequently, to varying degrees, there is revascularisation of the marrow from adjacent areas, there is reabsorption of dead bone and there is a laying down of new bone. At this stage as the perfusion increases and osteoblastic activity increases the uptake within the pathological area becomes greater than in normal bone. It becomes a hot spot. Then subsequently as the acute bone formation reduces, one may end up with bone that scintigraphically looks perfectly normal. In the end there is an area of dead bone and marrow surrounded by a fibrous capsule and outside this capsule there will also be calcification of the dead marrow. It is this calcification that produces the appearance seen on X-rays. However it takes months for the X-ray changes to develop.

What do these changes mean? In the shafts of the long bones, the osteonecrotic lesions probably mean very little because they seem to have no functional importance. It is very different with the juxta-articular lesions, which are mainly in the heads of the humerus and femur as these lead to joint damage. Gradually patches of dead bone develop under the joint surface. Dead bone is not as strong as living bone so the joint surface is inadequately supported leading to break up of the joint surface and eventually loss of joint function. Juxta-articular lesions have some importance, clinically speaking.

There are two ways of looking at the uptake of radio isotopes. Studies soon after injection reflect the rate of bone blood flow, or one can do late pictures, two or three hours after the injection which is what I usually deal with clinically.

At this point Dr Valk showed numerous slides of bone scans in patients with various forms of osteonecrosis. Common causes include fractured neck of femur, steroid therapy, chronic renal failure. A rare case he presented was the bone scan of a black patient after an acute crisis of sickle cell disease. These patients, after an acute crisis, have extensive revascularisation throughout the skeleton.

The most sensitive way of picking up bone necrosis is by bone scintigraphy. Why one wants to pick up bone necrosis is another question, but if one wants to spot osteonecrosis then this is the test one ought to be doing.

A CASE OF CEREBRAL GAS EMBOLISM

Chris Acott

This is the story of a 31 year old diver who had been diving for six months. He was NAUI qualified, holding a C card. He had had no medical examination before learning to dive, however when I examined him there was nothing of note in his past medical history.

He and his buddy went diving on a Sunday. Their first dive was to 30 feet for about 40 minutes. This depth was verified by his buddy, but he was equally uncertain about the time. However I know the area involved and the maximum depth could only have been 30 feet. The surface interval was not accurately timed, but it was probably about 40 minutes. They then went diving again. The patient only had about 700 psi in his tank. So it is not surprising that he ran out of air about 20 minutes later. He made a free ascent from 25-30 feet, breaking the surface about 5 seconds after lift off. The patient admits that everything that occurred after that is uncertain. His buddy