Case reports

Chronic compartment syndrome affecting the lower limb: MIBI perfusion imaging as an alternative to pressure monitoring: two case reports

Simon Owens, Philip Edwards, Ken Miles, Jumbo Jenner, Mike Allen

Abstract

Intracompartmental pressure monitoring remains the primary method of diagnosing chronic compartment syndrome. MIBI perfusion imaging is widely available and offers a radionuclear imaging technique for diagnosing this condition. Although the results are not identical with those from pressure monitoring, MIBI may offer a useful screening test for this condition.

(*Br J Sports Med* 1999;**33**:49–51)

Keywords: chronic compartment syndrome; MIBI perfusion imaging; compartmental pressure monitoring

Peter Wilson Sports Injury Clinic, Addenbrooke's NHS Trust, Hills Road, Cambridge CB2 2QQ, United Kingdom
J R Jenner
S Owens

Department of Nuclear Medicine, Addenbrooke's NHS Trust
P D Edwards

Department of Radiology, The Wesley Hospital, Chasely Street, Auchenflower, Queensland 4066, Australia
K A Miles

Department of Sports Medicine, Leicester General Hospital, Gwendolen Road, Leicester LE5 4PW, United Kingdom
M J Allen

Correspondence to:
Dr S J Owens.

Accepted for publication
26 August 1998

Chronic compartment syndrome should always be considered in the differential diagnosis of exercise induced lower limb pain, which also includes medial tibial stress syndrome (periostitis) and stress fracture. Mavor[1] was the first to describe the condition as anterior tibial syndrome, and since then the condition has become more frequently diagnosed with the increase in popularity of jogging and other endurance sports.

A unified concept to explain the condition was first proposed by Matsen in 1975, postulating that chronic compartment syndrome occurs when the exercise induced pressure within a fixed fascial compartment is raised sufficiently to produce ischaemia.[2] However, the pathophysiology of the condition continues to be poorly understood. The causes are probably many and other proposals for components that contribute to the condition have included oedema, accumulation of muscle metabolites, muscle hypertrophy, and thickened inelastic fascial compartments.[3]

Compartment syndromes remain difficult to diagnose. An accurate medical history is important as clinical examination often produces no conclusive results. The initial investigation may include a plain radiograph and bone scan to detect stress fractures. However, the ideal diagnostic test remains compartmental pressure monitoring.[4]

The diagnosis of chronic compartment syndromes is still reliant on accurate compartmental pressure measurement. There is still some debate about the most appropriate criteria for diagnosis. There can be practical difficulties in obtaining reproducible pressure readings, although in experienced hands accurate readings can be taken without too much difficulty. However, it requires insertion of a pressure monitoring catheter into the muscle compartment, which may be uncomfortable for the patient and has the potential for local complications.

We describe two cases that suggest that MIBI perfusion imaging may offer a simple, well tolerated, and readily available technique for diagnosing compartment syndrome.

MIBI perfusion imaging

MIBI perfusion imaging is a technique that assesses the uptake of an intravenously injected radiopharmaceutical, technetium-99m methoxyisobutyl isonitrile (MIBI), by peripheral muscles. The uptake of the radiopharmaceutical is largely determined by muscle perfusion but hypoxia also inhibits uptake of MIBI, enhancing its potential for detecting muscle ischaemia. The technique is already widely used for assessing myocardial perfusion and has also been shown to be of value in studying peripheral vascular disease and in diagnosis of popliteal artery entrapment.[5 6]

The imaging protocol is analogous to that used in myocardial perfusion imaging, but is directed at calf muscle perfusion in these two cases. The patients underwent graded treadmill exercise of sufficient intensity to reproduce the presenting symptoms. At peak exercise, 300 MBq of ^{99m}Tc-labelled MIBI was injected intravenously. Subsequent cross sectional imaging provided by emission tomography (SPECT) was used to detect regional abnormalities in muscle perfusion in the lower leg. Tomography was performed immediately after exercise and slices were reconstructed from ankle to knee at about 6 mm intervals—that is, 1 pixel thick. Images were packed into groups of three for final hard core copy. Where appropriate, coronal and sagittal slices were produced, but these were found to be less useful for comparative purposes. The images were displayed using a ten step colour scale which ranged from the blue end of the spectrum (low

Table 1 Comparison of results obtained by MIBI imaging and compartmental pressure monitoring

Case	Symptoms	MIBI imaging	Mean compartmental pressures during exercise (mm Hg)	Treatment	Outcome
1	Pain in bilateral anterior compartment; left > right	Left anterior compartment syndrome	RA 109 LA 57 RDP 23 LDP 28	Fasciotomy	Good
2	Pain in bilateral posterior compartment; right > left	Bilateral posterior compartment syndrome; left > right	RA 87 LA 113 RDP 140 LDP 102	Fasciotomy	Good

RA, right anterior; LA, left anterior; RDP, right deep posterior; LDP, left deep posterior. Normal range < 40 mm Hg for the deep posterior compartment and < 50 mm Hg for the anterior compartment.[7]

perfusion) through to the red end (high perfusion). The images were interpreted subjectively by an experienced consultant in nuclear medicine, although it is hoped that in future computer software will allow quantitative diagnostic criteria to be developed. The imaging criterion for a positive result was a visually detectable decrease in MIBI uptake in one or more compartments in the exercise study when compared with that taken at rest.

Resting data were also obtained on a second occasion to act as a control for the exercise test, and to exclude the presence of any ischaemia at rest that may be due to vascular pathology. The half life of the isotope is relatively short (about six hours), which makes it difficult to conduct both resting and exercise tests on the same day. However, it has been shown during myocardial and calf muscle perfusion studies that the decay in muscle isotope occurs relatively slowly allowing adequate time immediately after the exercise for accurate readings to be taken.

Case reports

CASE 1

A 39 year old office worker presented to the sports clinic with bilateral anterior lower limb pain. Over several years, he had noticed some intermittent tightening anteriorly in both lower legs on walking fast. He had then taken up jogging and, while running up to half a mile, developed bilateral pain consistently over the anterior lower legs, particularly on the left side, which required him to stop; his symptoms were gradually relieved over ten minutes.

On examination he was found to have some stiffness of the lower lumbar spine on extension, bulky calf and anterior tibial muscles without any focal muscle or bony tenderness, and normal peripheral pulses with no neurological signs.

CASE 2

A 24 year old sales officer presented with a one year history of cramp-like pains in both calves, which had gradually been worsening with running and would ease with rest over about ten minutes; the pains were worse in the right leg. Physical examination gave normal results apart from some bulkiness of the calf and anterior compartments.

TREATMENT

Both patients underwent MIBI perfusion imaging followed by pressure studies. Both required fasciotomy and had a satisfactory outcome (table 1 and fig 1).

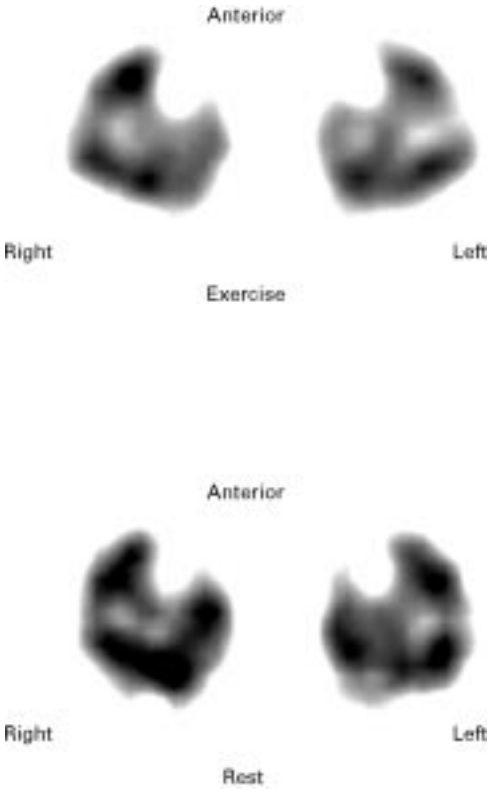

Figure 1 Emission tomograms at mid calf level showing regional distribution of technetium-99m methoxyisobutyl isonitrile (MIBI) immediately after exercise and at rest in case 1. The scan shows reduced uptake in the left anterior compartment after exercise compared with the scan taken at rest, indicating hypoperfusion.

Discussion

We are unaware of any previous reports that have compared MIBI perfusion imaging with pressure monitoring in compartment syndrome. The patients in the two cases presented here had classical histories of compartment syndrome. Both the MIBI imaging and pressure studies confirmed the clinical diagnosis, but in the first case the MIBI imaging only confirmed the diagnosis in the left anterior compartment whereas the pressure monitoring showed abnormalities in both anterior compartments, with the right being worse than the left, although the symptoms were worse on the left. In the second case, MIBI imaging again confirmed the clinical diagnosis but the mean compartmental pressures were greatest in the symptomatic calf, and the results also suggested that more compartments were involved. Both patients underwent surgical decompression with fasciotomy with a successful outcome in that they were asymptomatic 12 months after the operation.

Imaging techniques such as ultrasound, phosphorus nuclear magnetic resonance spectroscopy (PNMR), and magnetic resonance imaging (MRI) have as yet failed to prove useful as screening tools in chronic compartment syndrome.[3 8 9]

One other study has looked at the value of MIBI perfusion imaging compared with MRI

as a technique for diagnosing this condition, and concluded that it was not useful.[9] However, the development of SPECT has allowed more sensitive imaging of muscle perfusion.

MIBI perfusion imaging involves the patient being tested on two separate occasions, usually consecutive days, with the total dose of radiation being equivalent to three years of background radiation. Some experience is required to interpret the scans accurately. However, MIBI imaging is widely available in most district hospitals, whereas dynamic pressure monitoring can only be carried out in a few specialist centres. These preliminary studies suggest that the information acquired by the two techniques may not be identical but that MIBI imaging may be a useful screening test for this condition when compartmental pressure monitoring is not readily available.

A prospective trial comparing MIBI imaging with pressure monitoring and outcome would help to clarify the value of MIBI imaging as a screening tool for compartment syndrome and would determine the specificity and sensitivity of the two techniques.

1 Mavor GE. The anterior tibial syndrome. *J Bone Joint Surg [Br]* 1956;**38**:513–17.
2 Matsen FA. Compartmental syndrome: a unified concept. *Clin Orthop* 1975;**113**:8–14.
3 Balduini FC, Shenton DW, O'Connor KH, *et al*. Chronic exertional compartment syndrome: correlation of compartment pressure and muscle ischaemia utilising PNMR spectroscopy. *Clin Sports Med* 1993;**12**:151–65.
4 Pedowitz RA, Hargens AR, Mubarak SJ, *et al*. Modified criteria for the objective diagnosis of chronic compartment syndrome of the leg. *Am J Sports Med* 1990;**18**:35–40.
5 Miles KA, Barber RW, Wraight EP, *et al*. Leg muscle scintigraphy with 99Tc MIBI in the assessment of peripheral vascular arterial disease. *Nucl Med Commun* 1992;**13**:593–603.
6 Set PA, Miles KA, Jenner JR, *et al*. Demonstration of popliteal artery entrapment on leg muscle scintigraphy with 99mTc MIBI and single photon emission tomography. *Clin Radiol* 1995;**50**:404–8.
7 Allen MJ, Barnes MR. Exercise pain in the lower leg. Chronic compartment syndrome. Medial tibial syndrome. J Bone Joint Surg [Br] 1986;**68**:818–23.
8 Barnes M. Diagnosis and management of chronic compartment syndrome: a review of the literature. *Br J Sports Med* 1997;**31**:21–7.
9 Amendola A, Rorabeck CH, Vallett D, *et al*. The use of magnetic resonance imaging in exertional compartment syndromes. *Am J Sports Med* 1990;**18**:29–34.

Take home message

MIBI perfusion imaging is a technique that can be effectively used to diagnose chronic compartment syndrome. A prospective trial comparing MIBI with pressure studies would help to clarify whether the technique has a place as a screening investigation.

Commentary

This is an interesting new technique that eventually may shed some much needed light on the underlying causes of chronic compartment syndrome. However, there is still a way to go before it can be used routinely. As the authors suggest, there is a need for a prospective trial comparing MIBI imaging with pressure monitoring and outcome; "normal" studies would also be required. It is certainly true that the technology and expertise for this investigation are currently much more widespread than that used for direct compartment pressure measurements. However, I remain doubtful as to whether this could ever develop into a routine screening tool. It is a significantly different type of investigation producing images rather than numbers. I would be very interested to hear any views on the ethical balance between the radiation dosages required for this technique and the alternative methods of investigation.

M R BARNES
Leicester General Hospital