BONE SCINTIGRAPHY IN SYMPTOMATIC SPONDYLOLYSIS

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In 66 patients with back pain and suspected spondylolysis, the results of bone scintigraphy have been correlated with operative findings and clinical follow-up. Although bone scintigraphy is of little value for primary diagnosis, it helps to distinguish between those patients with established non-union of the defect, and those in whom healing is still progressing and who may benefit from immobilisation. We also found that increased uptake on the contralateral side to a unilateral spondylolysis is suggestive of impending fracture.

Lumbar spondylolysis is generally considered to be a fatigue fracture resulting from abnormal chronic or repetitive stress imposed on the spine in subjects with one or more inherited predisposing factors (Krenz and Troup 1973; Wiltse, Widell and Jackson 1975; Farfan, Osteria and Lamy 1976; Lafferty et al. 1977; Wynne-Davies and Scott 1979; Porter and Park 1982; Fredrickson et al. 1984). It usually occurs in young athletes or military recruits (Cyron, Hutton and Troup 1976; Jackson, Wilson and Cirincione 1976; Hithoshi 1980; Lowe et al. 1984). However, whereas most stress fractures heal when treated by immobilisation or when the causative stresses are removed, healing of an established spondylolysis is uncommon.

The sensitivity and accuracy of skeletal scintigraphy for detecting stress fractures in long bones is well established (Garrick et al. 1976; Prather et al. 1977). Lowe et al. (1984) found increased uptake in the spine in 25% of a population of military recruits with radiologically confirmed spondylolysis; the increased uptake occurred more frequently in patients whose symptoms were of less than one year's duration.

Actively healing fractures are characterised by an increased uptake of bone-seeking tracers which diminishes when non-union is established (Marty et al. 1976; Deutsch and Gandsman 1983). Particularly for the spine, radiographs are a very insensitive means of determining whether or not healing is still progressing. We have therefore reviewed a series of patients with back pain to

determine whether scintigraphy could be used to identify established non-union in the spine and whether, as in other sites, scintigraphic abnormalities may precede radiological changes.

PATIENTS AND METHODS

All patients under the age of 25 years with back pain who had undergone skeletal scintigraphy between 1978 and 1984 were identified from the records of the Medical Radio-isotope Department at the Western General Hospital, and 66 patients without primary or metastatic bone tumours, major trauma, infection, erosive arthritis or previous spinal fusion were included in this study. Bone scintigraphy had been performed 3 to 5 hours after intravenous injection of 400 MBq of ^{99m}Tc -MDP, using a gamma camera fitted with a high resolution collimator (Merrick 1984).

Radiographs, scintigrams and case histories were reviewed, and the radiographs and any dubious scintigrams were reviewed by two authors. Spondylolysis was considered to be present when both agreed that there was a defect in the pars interarticularis on one or both sides. Thinning or narrowing of the pars interarticularis without a definite osteolytic zone was regarded as dubious. Scintigraphy was reviewed with particular attention to the level and side of any focal areas of increased isotope concentration. Differences between groups were compared using the standard *chi*-square test, with corrections where appropriate.

RESULTS

Sixty of the patients with back pain had no scintigraphic abnormality, and 38 of these had no radiographic evidence of spondylolysis. None of these 38 developed a radiologically confirmed spondylolysis during the period of follow-up. There were thus no false-negative scintigrams in this group. Of the 22 other patients with no

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Table I. Patients with spondylolysis and positive scintigraphy

Case	Age (years)	Duration of symptoms	Evidence of spondylolysis		Management
			Positive radiograph	Positive scan	
1F	15	8 months	Bilateral L5	Bilateral L5	Corset 8 weeks
2M	16	4 months	Bilateral L5	Bilateral L5	No treatment
3M	11	6 months	Bilateral L5	Right L5	No sports
4M	24	8 months	Left L5	Right L5	Corset 8 weeks (operative repair 6 months later)
5M	14	3 weeks	Bilateral L4	Bilateral L4	Corset 8 weeks (operative repair 8 months later)
6M	13	3 months	Bilateral L5	Bilateral L5	Corset 8 weeks

scintigraphic abnormality (12 males and 10 females; mean age 17 years, range 14 to 25), 17 did have definite bilateral radiographic defects in the pars interarticularis and three ultimately developed a spondylolisthesis. The remaining five had dubious or equivocal radiographic abnormalities, none of which subsequently progressed to a definite spondylolysis. The abnormality was at L5 in 16, at L4 in five and at both L1 and L2 in one with spina bifida and scoliosis. Six were treated by operation, two by posterolateral spinal fusion and four by bone grafting of the defect and fixation with cerclage wire applied round the transverse and spinous processes, the so-called Edinburgh type of repair (Bradford and Iza 1985; Eingorn and Pizzutillo 1985).

Focal scintigraphic abnormalities were present in six cases, five of which were bilateral (Table I). None of these was hypertrophic. Case 4 underwent operative exploration after eight weeks' immobilisation, and the defect was confirmed to be on the left side only (Fig. 1). The pars interarticularis on the right, where there was increased uptake (Figs 2 and 3), was intact, although radiologically the bone texture appeared abnormal. Anti-clockwise rotation of the spinous process with minimal force appreciably increased the gap on the left (Fig. 4), whilst clockwise rotation reduced it (Fig. 5). Cephalocaudal movement had no visible effect, and this abnormal pliability of the intact pedicle has since been observed at operation in another patient (on whom scintigraphy was not performed) with pain on the contralateral side to the defect.

Table II. Duration of symptoms in patients with spondylolysis

Result of scintigraphy	Duration of symptoms*		Effect of sports†	
	< 1 year	> 1 year	Active	Inactive
Negative	13	4	7	10
Positive	6	—	6	—

* $\chi^2 = 0.29$, d.f.1; $p = 0.56$ (not significant)† $\chi^2 = 3.28$, d.f.1; $p = 0.07$

In Case 5, when scintigraphy was repeated after four months' immobilisation, the defect appeared normal but radiologically there was increased width of the radiolucent zone in the pars interarticularis. Bilateral spondylolysis was confirmed at operation, when a bilateral Edinburgh repair was performed. Repeat scintigraphy and radiography of Case 6 one year after immobilisation in a plaster jacket for eight weeks (with relief of symptoms) were both normal.

DISCUSSION

Humphreys et al. (1979) suggested that scintigraphy should not be used as a primary investigation for spondylolysis in children and adolescents with back pain. Our findings confirm this. The majority of patients with a proven spondylolysis (74% in the present series) had no scintigraphic abnormality. There is, however, an association between scintigraphic abnormalities in young individuals and recently increased physical exertion or specific trauma. Lowe et al. (1984) found that a history of pain for less than one year correlated with the development of stress fracture, the associated osteogenesis and repair being responsible for the high isotope uptake seen scintigraphically.

Our study differs from his in that, whilst he was studying a high risk group of young military recruits, our patients, though all aged less than 25, were from the general population and had been referred to an orthopaedic clinic because of back pain. All of our patients with scintigraphic abnormalities had suffered symptoms for less than a year (Table II), and we also found, as did Lowe et al. (1984), an association between a history of increased physical exertion and the development of spondylolysis. This is in keeping with the clinical observation that, whilst spondylolysis is commonly asymptomatic (Jackson et al. 1976; Torgerson and Dotter 1976; Hithosi 1980), those patients with symptoms are more likely to be recent (Hazlett 1984; Porter and Hibbert 1984). A correlation between increased isotope uptake and pain has also been noted in other sites (Merrick and Petrie 1985).

Fig. 1

Fig. 2

Case 4. Figure 1. An oblique radiograph shows the defect in the left pedicle of L5. Figure 2 - No defect is visible in the pars articulares at any level, but there is sclerosis of the right pedicle of L5. Figure 3 - A scintigram shows increased uptake in the region of the right pedicle of L5. Figure 4 - The effect of applying an anti-clockwise rotation to the spinous process. Figure 5 - A clockwise rotation.

Fig. 3

Fig. 4

Fig. 5

Further support for this hypothesis is provided by Papanicolaou et al. (1985), who found radiographic evidence of spondylolysis in 15 of 40 young athletes with a history of back pain of "several weeks' to several months' duration", 10 of whom had corresponding scintigraphic abnormalities. Four others had focal scintigraphic abnormalities with normal radiographs; in two the radiographs were still normal 3 to 5 months later, whilst a third developed bilateral spondylolysis at the level of the scintigraphic abnormality (the fourth was lost to follow-up). There was no indication of the treatment any had received, or whether symptoms had persisted.

Established non-union is scintigraphically inactive (Marty et al. 1976). Non-visualisation of the majority of

spondylolyses in the present series (most of which were of long standing) and the findings in Case 5, where a deterioration of the radiological appearance was associated with the disappearance of the scintigraphic abnormality, are both evidence that significant repair had ceased and there was little prospect of spontaneous healing of the bony defect.

It is well established that, in limb bones, increased isotope uptake precedes obvious radiological evidence of stress fracture (Garrick et al. 1976; Prather et al. 1977). There can be little doubt that, in Case 4, the changes on the side with no radiographic evidence of spondylolysis but which was abnormal at operation were the early stages of a stress fracture; if left untreated, the defect

may well have progressed to a fracture, as did one of Papanicolaou's patients (1985). The apparent rarity of this observation is merely a reflection of the (entirely proper) delay in referring young patients with back pain, normal radiographs and short duration of symptoms for scintigraphy before simple conservative treatment has been tried.

It is thus possible to identify five distinct groups of patients:

1. Those in whom there is no radiological evidence of a spondylolysis and scintigraphy is normal. Back pain in these patients must be due to some other cause.
2. Patients with radiographically confirmed spondylolysis but no focal accumulation on scintigraphy. In these patients there is an established non-union which is unlikely to heal with immobilisation alone. This may have medico-legal implications in patients examined within one year of an accident alleged to be the cause of a spondylolysis.
3. Patients with a spondylolysis associated with increased uptake on the scintigram. Healing is still progressing and, as seen in Case 6, there is a possibility of bony union with immobilisation.
4. Patients with a unilateral spondylolysis and scintigraphic changes on the contralateral side. These are at imminent risk of developing a bilateral spondylolysis.
5. Patients with unilateral or bilateral focal scintigraphic abnormalities who have not yet developed a radiographic spondylolysis. In view of the high sensitivity but low specificity of scintigraphy, great caution must be exercised before diagnosing spondylolysis.

We believe that this re-evaluation clarifies the role of scintigraphy in the management of spondylolysis. Although not formally proven in a prospective study, there is very strong circumstantial evidence that, by determining whether there is still active healing, scintigraphy assists in the choice between conservative and operative management.

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