Scintigraphy in the assessment of anterior knee pain

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Sixty knees presenting with chronic anterior pain were investigated. A diffusely increased uptake indicated sympathetically mediated pain provided other diagnoses such as synovitis or widespread arthrosis were excluded. Focal uptake was not specific to any one condition, but could occur in chondromalacia patellae or recent dislocations. However, the commonest appearance found in chondromalacia patellae was a normal scan. A characteristic scintigraphic appearance in symptomatic postpatellectomy knees, which has not been previously reported, was increased uptake in the femoral groove. In all the cases where no clinical or arthroscopic diagnosis was made, the bone scan was normal.

The use of radioisotope scintigraphy is recommended in the problem knee presenting with anterior pain.

It is widely accepted that bone scintigraphy is a valuable technique in the diagnosis of many well-defined orthopedic conditions (Bauer 1968). Although scintigraphic abnormalities may also occur in chondromalacia patellae (Dye and Boll 1986, Hejgaard and Diemer 1987) and in the syndrome of sympathetically mediated pain (Simon and Carlson 1980, Katz and Hungerford 1987, Ogilvie-Harris and Roscoe 1987), the role of scintigraphy in the assessment of these and other causes of the anterior knee pain syndrome is not well established.

Our aim has been to evaluate the role of ^{99m}Tc bone scintigraphy in the anterior knee pain syndrome, defined as anterior pain of greater than 6 months' duration that is exacerbated by activity, particularly climbing stairs, and is associated with weakness, giving way, and pain on sitting.

Patients and methods

Fifty-five patients (60 symptomatic knees) were studied. There were 25 males and 30 females with a mean age of 29 (15–48) years. All the patients were attending a specialist knee clinic and underwent a thorough clinical examination and plain radiography. Forty-nine of the 60 knees (including all the knees suspected of chondromalacia patellae) underwent arthroscopy, performed by 1 experienced surgeon via the anterolateral and superolateral portals. Only knees where the clinical diagnosis was not in doubt were not arthroscoped: viz., three knees with postpatellectomy syndrome, four with sympathetically mediated pain, two following patellar dislocation, and two with soft-tissue diagnoses.

Anterior, posterior, and lateral static images of both knees were obtained using an IGE maxi gamma camera 3 hours after injection of 550 MBq of ^{99m}Tc-HMDP. Dynamic scans were not performed routinely, although they were performed in 11 patients. All the scans were assessed by 1 of the authors without knowledge of the clinical, arthroscopic, or radiographic findings. The scans were examined systematically using a qualitative technique. Each knee was assessed for focal abnormalities in the extensor mechanism (patella, femoral groove, and tibial tubercle) and the medial or lateral compartments of the tibiofemoral joint. In this manner three groups were identified: (1) Normal appearances; (2) focal uptake in the patella, femoral groove, or tibial tubercle; (3) diffuse uptake throughout the knee.

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Table 1. Scintigraphy in 55 cases of anterior knee pain

Patient	A	B	C	D	E	F	G
01	29	F	3	2	–	2	3
02	43	M	3	2	+	2	3
03	48	M	3	2	–	2	3
04	39	M	3	2	+	2	3
05 (L)	30	F	3	3	+	2	3
06	34	M	2	1	–	2	3
07	28	M	2	2	+	2	3
08	32	M	3	3	+	3	3, 1
09	22	F	3	3	+	3	3, 1
10	26	F	2	2	+	1	2
11	19	F	1	2	+	1	2
12	23	F	2	1	+	1	2
13	35	M	2	2	+	1	2
14 (L)	36	M	2	2	+	1	2
15	24	F	2	2	+	1	2
16	33	F	3	3	+	1	2
17	30	M	1	1	+	1	2
18	21	F	3	1	+	1	2
19	24	F	2	2	+	1	2
05 (R)	30	F	2	2	+	1	2
20 (L)	24	M	2	2	+	2	2
21	26	M	1	1	+	2	2
22 (L)	34	F	3	2	+	2	2
22 (R)	34	F	3	2	+	2	2
23	33	M	2	2	+	2	2
24	48	F	2	2	+	2	2
25	47	F	2	2	+	2	2
26	24	F	3	1	+	1	1
27	19	F	2	1	+	1	1
28	21	M	2	0	+	1	1
29	22	F	3	0	+	1	1
30	22	M	2	1	+	1	1
31	35	M	2	2	–	2	1
32	23	F	3	0	+	2	1
33	22	F	3	1	–	3	1
34	23	F	3	1	+	3	1
35	29	M	3	1	+	3	1
14 (R)	36	M	2	1	+	3	1
20 (R)	24	M	2	1	+	3	1
36	24	F	2	1	+	3	1
37	18	F	2	1	+	3	1
38	22	M	3	1	+	3	1
39	31	M	3	1	+	3	1
40	34	F	3	1	+	3	1
41	39	M	2	2	–	3	1
42	26	F	3	1	–	3	1
43	44	F	3	1	+	1	4a
44	15	M	1	1	–	1	4b
45	38	M	1	1	+	1	4c
46	29	F	2	1	–	1	4d
47 (L)	25	F	3	2	–	2	4e
47 (R)	25	F	1	1	–	1	4f
48	22	F	2	2	+	1	4g
49	33	M	2	2	+	1	4g
50	19	F	2	2	+	2	4g
51	32	M	3	0	+	1	5
52	19	M	2	0	+	1	5
53	31	F	2	0	+	1	5
54	24	F	2	0	+	1	5
55	58	M	3	0	+	1	5

A Age
B Sex
C Symptom score (see text)
D Pathology score (see text)
E Arthroscopic status
F Scan appearance
  1 normal
  2 focal
  3 diffuse uptake
G Diagnosis
  1 sympathetically mediated pain
  2 chondromalacia patellae
  3 postpatellectomy syndrome
  4 miscellaneous
    a quadriceps tendinitis
    b patellar tendinitis
    c degenerate medial meniscus
    d soft-tissue injury
    e recent patellar dislocation
    f old patellar dislocation
    g femoral condylar chondromalacia
  5 no organic disease

After the scans had been classified, the clinical details were obtained from the case records and the knees were classified into the following diagnostic groups without reference to the scans.

1. *Sympathetically mediated pain* (reflex sympathetic dystrophy) was defined as "continuous pain in a portion of an extremity after trauma, which may include fracture but does not involve a major nerve, associated with sympathetic hyperactivity" (International Association for the Study of Pain, Subcommittee on Taxonomy 1986). In the knee, it is characterized by a continuous burning pain, increased sweating, and alteration in skin temperature and colour.

2. *Chondromalacia patellae* was strictly defined as softening of a zone of patellar articular cartilage identified at arthroscopy. It was not used to describe the clinical syndrome of anterior knee pain. This group did not include knees with mild chondromalacia patellae that were complicated by sympathetically mediated pain.

3. *The postpatellectomy syndrome* was defined as chronic anterior knee pain with weakness and giving way following patellectomy.

4. *Miscellaneous conditions* included chrondromalacia of the medial or lateral femoral condyles, recurrent dislocation of the patella, quadriceps and patellar tendinitis, fat necrosis after crush injury, and degenerate medial meniscus.

5. *No organic diagnosis* was made despite full investigation, which included arthroscopy in all the cases.

The severity of the symptoms was then assessed on a scale of 0–3 for each symptomatic knee. The severity of the pathology was also assessed on a scale of 0–3 on the basis of the arthroscopic, operative, and radiographic appearances. Finally, a correlation was made between the symptoms, the pathology, and the appearance of the scan for each knee (Tables 1 and 2).

Table 2. Bone scan appearances and mean scores for symptoms and pathology for each diagnostic subgroup

Scan	n	Symptoms (S)	Pathology (P)	S:P ratio
Sympathetically mediated pain				
Normal	5	2.4	0.6	4.0
Focal	2	2.5	1.0	2.5
Diffuse	14	2.6	1.4	1.9
Chondromalacia patellae				
N	11	2.0	1.8	1.1
F	7	2.1	1.9	1.1
D	0	–	–	–
Postpatellectomy				
N	0	–	–	–
F	7	2.7	2.0	1.4
D	2[a]	3.0	3.0	1.0
Miscellaneous				
N	7	1.7	1.3	1.5
F	2	2.5	2.0	1.3
D	0	–	–	–
No diagnosis				
N	5	2.4	0.0	∞
F	0	–	–	–
D	0	–	–	–

[a]These two knees were also complicated by sympathetically mediated pain. They are therefore included under both the "sympathetically mediated pain" and "postpatellectomy" headings.

Results

Of the 21 knees with sympathetically mediated pain, 14 had diffuse uptake (Figure 1), two had focal uptake in the patella, and five had normal scans. The ratio of the mean scores for symptoms to pathology was high, particularly for those with normal scans.

Of the 18 knees with arthroscopically proven chondromalacia patellae, 11 had normal scans and the other seven had focal uptake in the patella (Figure 2). There was no correlation between the severity of the chondromalacia and the scan appearance.

All nine knees with the postpatellectomy syndrome had increased uptake in the femoral groove (Figure 3). Two knees also had clinical evidence of sympathetically mediated pain, and they both demonstrated a diffusely increased uptake on the scan in addition to the uptake in the femoral groove. The postpatellectomy knees had the highest mean score for symptoms of any diagnostic group.

Only two out of the nine knees in the miscellaneous group had positive scans (a recently dislocated patella and a case of chondromalacia of the medial femoral condyle). Although the number of knees with positive scans was small, they had a high mean score for symptoms and a moderate mean score for pathology.

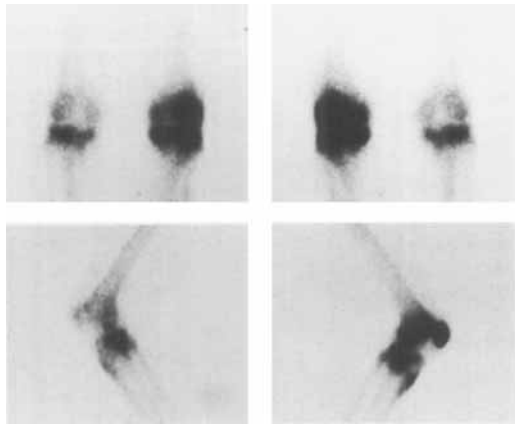

Figure 1. (Case 42). Bone scan showing diffusely increased uptake in the left knee of a patient with sympathetically mediated pain.

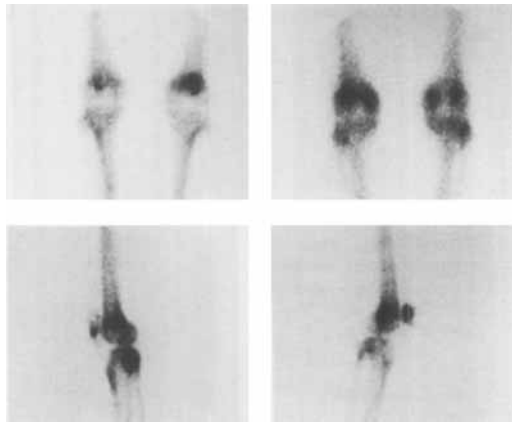

Figure 2. (Case 21). Bone scan demonstrating focally increased uptake localized to the left patella in a patient with chondromalacia patellae.

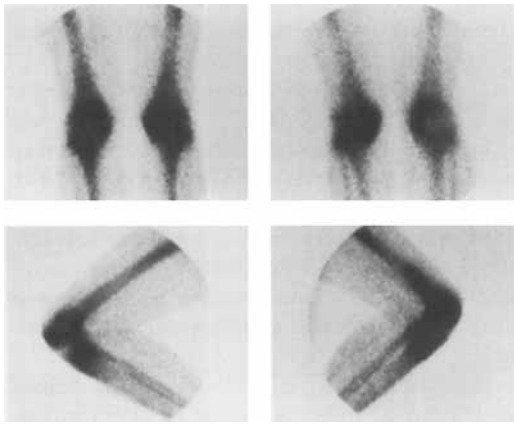

Figure 3. (Case 05). Bone scan demonstrating the typical appearance in the postpatellectomy syndrome with increased uptake in the left femoral groove. There is also increased uptake in the right patella.

No organic diagnoses were made in five knees. The mean score for symptoms was moderately high.

Eleven knees were investigated with dynamic scintigraphy. Four had normal static scans, and also had normal early and blood-pool images. Five had focal uptake on the static images, and had normal early images with marginally increased uptake on the blood-pool images. Two had diffuse uptake on the static images, and also had diffuse uptake on the early and blood-pool images.

Discussion

Most reports of the use of bone scintigraphy in anterior knee pain have been concerned with sympathetically mediated pain. In one of the first reports in the English literature (Tietjen 1986), only six knees were investigated, four of which had positive scans. In a subsequent study (Coughlan et al. 1987), nine out of 18 knees had positive scans. Unfortunately, neither study specified how many of the positive scans showed diffuse or focal uptake.

Katz and Hungerford (1987) investigated 13 knees with evidence of sympathetically mediated pain, and found that five had normal scans while eight had increased uptake on the delayed static images. Six of these were diffuse with increased uptake throughout the knee while two were focal, i.e., localized to the patella. The mean interval between the onset of symptoms and scintigraphy was 14 (5–36) months. Ogilvie-Harris and Roscoe (1987) investigated 17 knees using dynamic scintigraphy. They found that all six knees scanned within 6 months of the onset of symptoms had positive scans, whereas six out of eight knees scanned more than 6 months after the onset of symptoms had positive scans. There were 3 other cases where the symptoms were precipitated by surgery. All 3 had positive scans, but it was not stated whether these scans were early or late.

In our study, all the scans were performed more than 6 months after the onset of symptoms. Our findings (16 positive out of 21 knees) correlate well with those of Ogilvie-Harris and Roscoe (1987), who showed that 6 out of 8 of their patients had positive scans when performed over 6 months after the onset of symptoms. Three knees in our study initially had diffusely increased uptake that subsequently returned to normal. In one of these knees, the return to normality of the scan was associated with resolution of symptoms, whereas the other two knees showed no symptomatic improvement. The following can, therefore, be concluded:

1. Diffusely increased uptake indicates sympathetically mediated pain (Figure 1) provided other diagnoses such as synovitis (e.g., infection or rheumatoid arthritis) or widespread arthrosis can be excluded.

2. Focal patellar uptake may occur in sympathetically mediated pain, although it is not diagnostic, as it may also occur in mechanical conditions of the patella, e.g., chondromalacia, dislocations, and fractures.

3. A normal scan does not preclude the diagnosis of sympathetically mediated pain if the scan has been done late in the course of the disease.

The relationship between bone scan appearance and chondromalacia patellae reported in the literature is confusing. This may be due to differences in the populations studied, but equally important is the fact that some authors have studied the incidence of chondromalacia in "hot" bone scans (Kohn et al. 1988), whereas others have studies the incidence of "hot" bone scans in chondromalacia patellae (Kaufman and Langlotz 1984, Dye and Boll 1986, Hejgaard and Diemer 1987). Only in the latter group can the value of scintigraphy in chondromalacia be truly assessed.

Kohn et al. (1988) studied 100 consecutive knees in sportsmen and sportswomen diagnosed as having chondromalacia patellae on clinical grounds. Ninety-seven had positive scans and 50 of these underwent arthroscopy. Of these 50, 43 had chondromalacia patellae confirmed. They also reported a correlation between the severity of the chondromalacia and the intensity of the patellar uptake. Unfortunately, no patients with normal scans were arthroscoped, so they were unable to assess the sensitivity of scintigraphy in the diagnosis of this condition. Hejgaard and Diemer (1987) studied 64 knees with chondromalacia patellae. They found that 39 scans were positive. Although no correlation between the intensity of abnormal uptake and the severity was shown in this study, it was found that the proportion of positive scans increased with the severity of the chondromalacia.

In contrast to the studies of Kohn et al. (1988) and Hejgaard and Diemer (1987), no demonstrable correlation between the severity of the chondromalacia patellae and the scan appearance was found in our study. Our finding that the sensitivity of scintigraphy in the diagnosis of chondromalacia was low is supported by Kaufman and Langlotz (1984); they found that only 2 out of 9 arthroscopically proven cases of chondromalacia had abnormal findings on scintigraphy.

The increased uptake in the femoral groove that characterised our postpatellectomy patients was un-

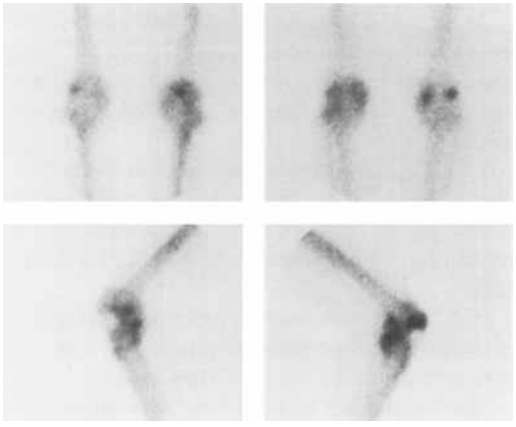

Figure 4. (Case 25). This patient was referred with unexplained anterior knee pain. Arthroscopy had been reported as normal. However, her bone scan showed marked increased uptake in the left patella. On repeat arthroscopy using the superolateral approach, it was found that she had a large chondral defect in the patella with chondromalacia of the surrounding area.

likely to have been due to the patellectomy itself, because this had been performed at least 3 years before the bone scan in all the cases. It is more likely that this increased uptake was due to increased stress from continued maltracking or subluxation of the patellar tendon, or from chondromalacia of the femoral groove itself. Chondromalacia of the femoral groove was in fact confirmed arthroscopically in 2 of the 6 cases that were arthroscoped. Full assessment of the significance of the scintigraphic findings would require a control group of patients who had done well following patellectomy.

The majority of knees in the miscellaneous diagnosis subgroup had normal scans including 1 case of jumper's knee (patellar tendinitis) and 1 case of a related condition, quadriceps tendinitis. Our findings contrasted with those of other authors (Kahn and Wilson 1987), who reported focal uptake in the lower pole of the patella in 3 cases of jumper's knee.

The subgroup of knees in which no organic diagnosis was made despite thorough investigation including arthroscopy, interestingly, demonstrated normal scan appearances in all 5 cases. Although we have demonstrated that a normal scan by itself cannot rule out chondromalacia patellae, sympathetically mediated pain, or other conditions such as jumper's knee, it would appear that when combined with a normal clinical examination and a normal arthroscopy, the chances of making an organic diagnosis are small. Although it is not specific to any one condition, a positive scan is one indication for a repeat arthroscopy where no diagnosis has been made, as it may indicate that a mechanical disorder has been missed (Figure 4).

Dynamic scintigraphy was not found to be of any additional benefit in any of our cases. Other studies have suggested that dynamic scintigraphy may be of only limited additional value in the syndrome of sympathetically mediated pain. Ogilvie-Harris and Roscoe (1987) reported that the characteristic scintigraphic appearance in this syndrome was increased uptake in the involved knee both on the blood pool and on the delayed static images. In a study predominantly involving the upper limb (Kozin et al. 1981), 35 patients with features of sympathetically mediated pain were investigated. Positive scans occurred in 21/35 of the static images and in 18/33 of the early and blood-pool images, suggesting that the dynamic scans did not contribute in diagnosis.

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