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Transient ischaemia of the proximal femoral epiphysis in the child

Interpretation of bone scintimetry for diagnosis in hip pain

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^{99m}Tc-MDP-scintimetry was performed in 25 consecutive cases of radiographically silent transient synovitis of the hip in children. Fourteen cases had normal scintimetry; seven cases had an increased uptake in the epiphysis; four cases had markedly defective uptake in the epiphysis, indicating interrupted vascular supply. At repeat scintimetry 6 weeks later, the uptake was normal or increased in three of these four cases; the one case with a persistent defect was the only case in this series who later developed radiographic evidence of Legg-Calvé-Perthes' disease.

In some cases presenting with clinical symptoms of synovitis of the hip, there is a transient, spontaneously recovering ischaemia of the proximal femoral epiphysis, not followed by radiographic evidence of necrosis. This should be considered in attempts to make a pre-radiographic diagnosis of Legg-Calvé-Perthes' disease by radionuclide methods.

^{99m}Tc-MPD-scintimetry in the early stages of Legg-Calvé-Perthes' disease (LCPD) has revealed a characteristic pattern of defective uptake in the proximal femoral epiphysis (PFE) (Danigelis et al. 1975, Fasting et al. 1978, Bensahel 1980, Sutherland et al. 1980, Tachdjian 1980, LaMont et al. 1981), which was faintly displayed by 18-F scintigraphy (Bohr 1973). However the hope of establishing the diagnosis of LCPD by scintimetry in the radiographically silent stage of the condition has been contradicted by reports of cases of hip pain in whom a defective PFE uptake became normal without development of radiographic abnormalities (Sutherland et al. 1980, Kloiber et al. 1983).

The purpose of this study was to describe the ^{99m}Tc-MPD-scintimetry pattern in children with the clinical diagnosis of transient synovitis and to follow the natural history of cases with evidence of defective PFE vascularity.

Patients and methods

Twenty-seven consecutive 1–11-year-old children presenting with clinical symptoms of transient synovitis of the hip were admitted; 19 were boys, and eight were girls (Table 1). All children underwent radiographic examination of the hips and pelvis in the neutral and in the frog-leg position and were treated with bed-rest. Scintimetry was performed in 26 out of 27 patients within 12–72 h of admission to the hospital; one patient was excluded due to lack of cooperation. In eight cases follow-up scintimetry was performed 27–70 (median 42) days after the initial scan. ^{99m}Tc-MPD was given intravenously in an age-related dose from about 100 MBq in the youngest to 200 MBq in the oldest children. Delayed anterior images of the pelvis and both hips were obtained 3–4 h after injection using the parallel-hole collimator, and anterior views of each hip separately in neutral position were obtained using a pin-hole collimator with a 4 mm aperture. The images were evaluated visually and quantitatively as follows.

1. The pin-hole image activity in *a region of interest* in the lateral part of the epiphysis was related to a region of reference in the neck of the femur. This ratio was related to the corresponding ratio in the contralateral hip and given as a percentage (Table 1).
2. *A profile of interest* was selected from the metaphyseal region, perpendicular to the growth plate, across the lateral part of the epiphysis, across the joint space and into the acetabulum. The activity along this profile was displayed graphically to relate the isotope uptake to anatomic details and facilitate comparison with the contralateral non-symptomatic hip.

All children had clinical and radiographic follow-up at 5–11 months.

Table 1. Clinical and scintimetric data in 26 patients with transient synovitis of the hip

A	B	C	D	E	F	G	H	I	J	K	L	M
1	7	M	R	5	no	8	37.8	0.49	1.30	38	137	
2	8	M	L	4	no	58	38.3	0.62	1.09	57	104	
3	4	M	L	4	no	12	36.6	0.51	1.05	48	58	[a]
4	7	M	L	2	no	2	38.0	0.88	1.16	77		
5	7	M	L	30	no	21	37.2	1.39	1.25	111	121	
6	10	M	R	4	no	4	37.3	1.40	1.31	102		
7	6	F	L	5	no	17	36.8	1.40	1.24	113		
8	8	M	R	7	no	5	37.9	1.47	1.39	106		[b]
9	9	F	R	3	yes	5	36.5	1.73	1.78	98	91	
10	7	M	R	3	no	7	36.2	1.05	0.90	117		
11	6	M	L	8	no	–	–	1.51	1.28	118		
12	11	F	L	3	yes	2	36.0	1.45	1.74	83		
13	6	M	R	16	no	14	37.3	1.59	1.32	120		
14	10	M	L	27	yes	7	36.5	1.39	1.18	118		
15	10	M	R	3	yes	12	37.8	–	–	–		[c]
16	6	M	R	3	no	7	37.3	0.83	0.75	110	122	
17	5	M	R	67	yes	–	–	0.88	0.82	107		
18	1	F	R	5	no	21	38.4	1.10	1.01	109		
19	4	F	L	2	no	3	37.0	0.90	1.60	56	119	
20	6	F	R	2	no	3	37.4	1.64	1.42	87		
21	5	M	R	5	no	16	37.5	1.67	1.50	111		
22	9	M	L	10	yes	26	37.1	1.23	1.44	86		
23	3	F	R	6	no	7	37.3	1.69	1.43	118		
24	5	M	L	5	no	9	36.1	1.17	1.44	81	115	
25	8	F	R	15	no	12	37.4	1.38	1.16	119		[d]
26	10	M	L	1	yes	9	36.2	1.15	1.23	94		

[a] 6 weeks later, radiographic evidence of LCPD.
[b] Transient recurrence 1 month after initial episode.
[c] Recurrent arthralgias, referred for rheumatological examination.
[d] Transient recurrence 1 month after initial episode.

Key to data in Table 1:
A = Case number; B = Age; C = Sex; D = Right/left symptomatic hip; E = Duration of symptoms at time of initial scintimetry (days); F = Previous episode/episodes of transient synovitis; G = Erythrocyte sedimentation rate (mm/hour); H = Body temperature at time of admission (°C); I = Epiphysis/neck ratio in the affected hip; J = Epiphysis/neck ratio in the non-affected hip; K = I/J – ratio (%); L = As in K in follow-up examination; M = Comments.

Results

The initial radiographic examination was normal in all children. The follow-up examinations were all normal, except Case 3 who developed radiographic evidence of LCPD (Table 1).

In all cases except in Case 3, the clinical symptoms subsided within a week. At follow-up, Cases 8 and 25 had each had one additional transient episode of pain within a month after the initial episode. Case 15 had recurrent arthralgia from several other joints after the initial episode; this child was referred for rheumatological examination, so far with negative results.

The visual scintimetric findings were as follows: in 14 cases the uptake was symmetric in both hips; in seven cases there was a diffusely increased uptake involving the epiphysis; in four cases there was a decrease in uptake isolated to the PFE, and in two of these visual uptake was absent (Cases 1 and 3). In Case 15, due to technical error, no evaluation could be performed.

The epiphysis/neck scintimetric ratio was increased in the affected side as compared to the control unaffected side (>100%) in 14 cases, and decreased (<100%) in 11 cases (Table 1). Correlation of visual and numerical evaluation proved good (Figure 1). In four cases with a

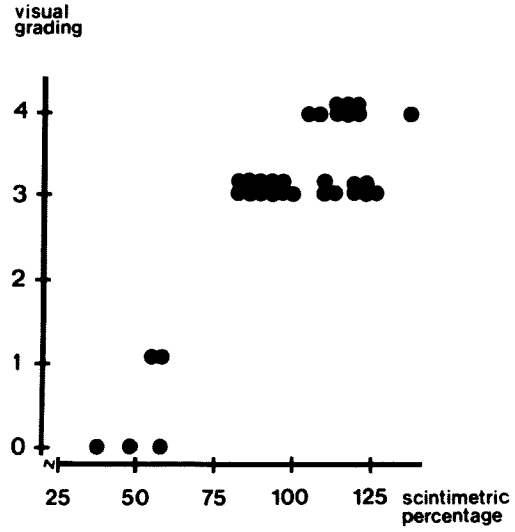


Figure 1. Comparison of visual and scintimetric evaluation of the activity in the proximal femoral epiphysis in the symptomatic versus non-symptomatic hip. Visual grading: 0 = absent; 1 = markedly reduced; 2 = slightly reduced; 3 = symmetric; 4 = increased PFE activity in the affected hip. Scintimetric evaluation: ratio symptomatic versus non-symptomatic hip (per cent).

marked decrease in uptake in the PFE in the initial scan (Cases 1, 2, 3 and 19) follow-up scintimetry approximately 6 weeks later showed restitution of isotope uptake in three of these, whereas in one the defective uptake persisted (Figure 2). This case subsequently developed radiographic evidence of LCPD (Case 3). In four patients with visually symmetric or increased PFE activity, repeat scans were unaltered in three, whereas in one patient activity was increased (Figure 2).

Case. 1. A 7-year-old boy with no previous history of hip problems presented with a 5-day-history of right hip pain and limp. Scintimetry revealed a 62 per cent reduction of uptake over the affected PFE, indicating a marked disturbance of blood supply to this region (Figure 3). Clinical symptoms subsided within a week, and a follow-up scan 6 weeks later showed an increased uptake in the PFE, indicating restitution of blood supply. The follow-up radiograph was normal then and again 5 months later. The boy had no further clinical symptoms.

Case 2. An 8-year-old boy with no previous history of hip problems presented with a 2-day-history of intense pain in his left knee-hip-region. To rule out septic arthritis, the hip joint was aspirated for 2 ml of clear effusion. Two days later scintimetry revealed a 43 per cent reduction of uptake over the PFE, indicating a marked disturbance of blood supply to this region (Figure 4). Clinical symptoms subsided within a week; 6 weeks later the radiograph was still normal, and the follow-up scan showed an increased uptake in the affected PFE, indicating restitution of blood supply. At follow-up 5 months later, there had been no further clinical symptoms and the radiograph was normal.

Case 3. A 4-year-old boy with no previous history of hip problems presented with a 4-day history of left hip pain. Scintimetry showed a 52 per cent reduction of uptake over the PFE, and the boy had continuing clinical symptoms. For this reason a repeat scan was performed 10 days later; it showed a persisting PFE defect (Figure 5). The joint was then aspirated but no effusion was found. This boy has had continuing clinical symptoms with pain and restricted motion. A follow-up scintimetry 6 weeks after onset of clinical symptoms revealed a persisting PFE defect, and radiographs at that time showed conclusive evidence of LCDP in the affected hip. Further follow-up showed a progressive clinical and radiographic development of LCPD.

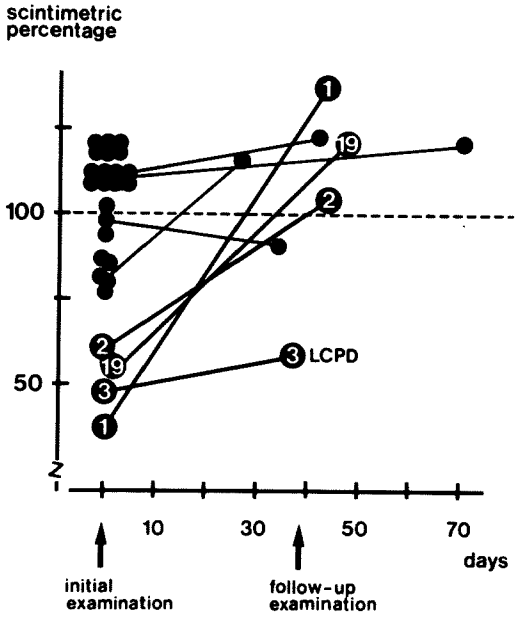


Figure 2. Scintimetric percentage (ratio symptomatic versus non-symptomatic hip) at the initial examinations and at follow-up examinations. In Case 3 the PFE defect persisted. This case subsequently developed LCPD.

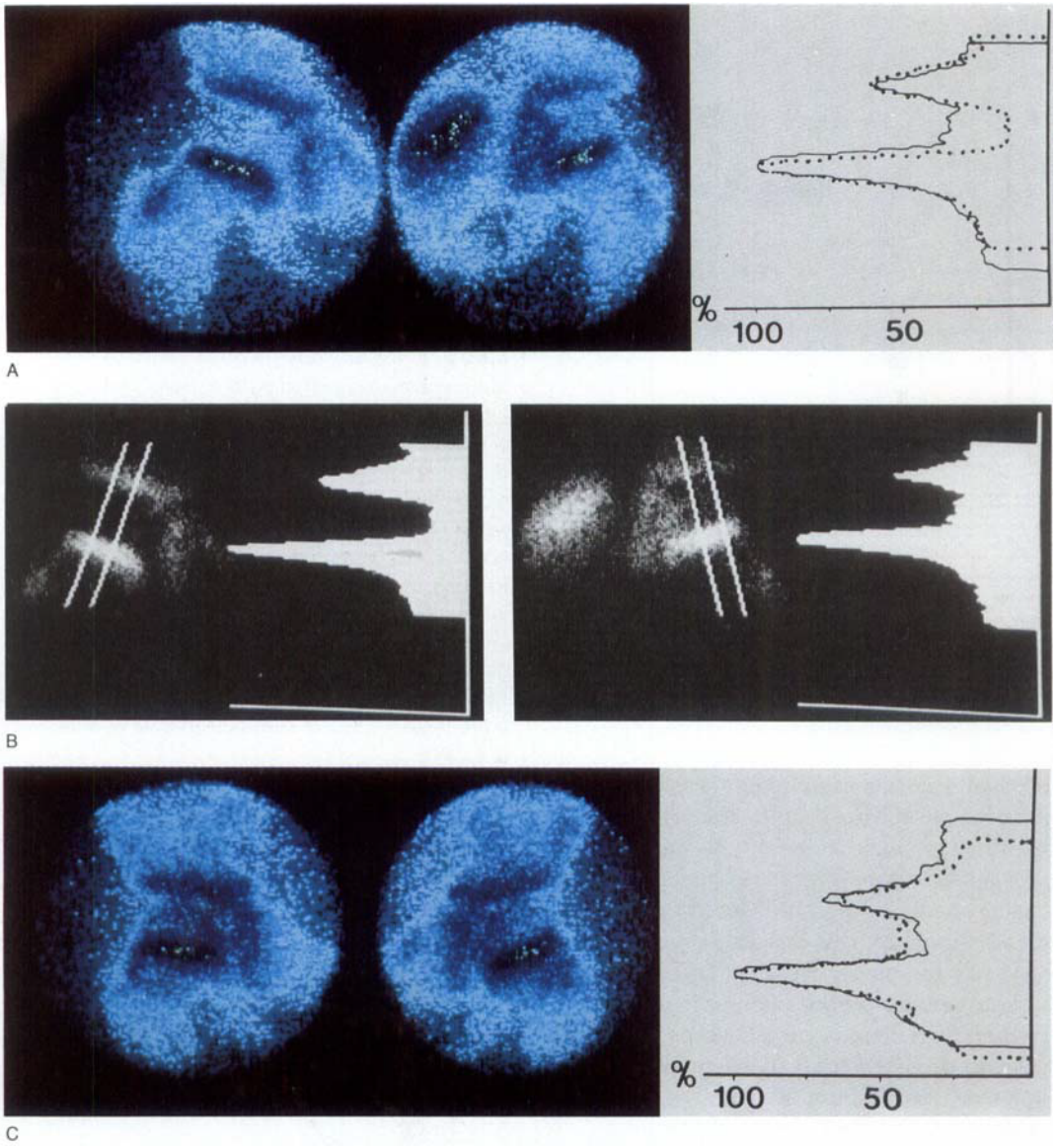
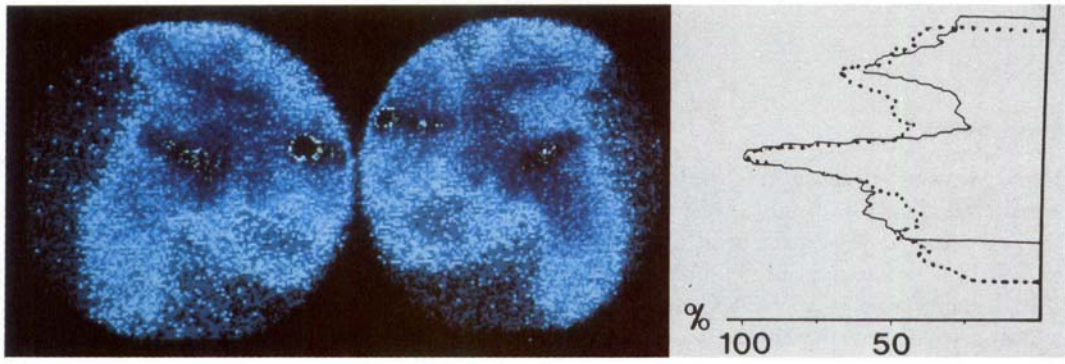


Figure 3. Case 1 with transient ischaemia of the epiphysis of the right hip. This patient did not develop radiographic evidence of LCPD.

A. Initial pin-hole images of both hips in AP-views with a marked *defect* in isotope-uptake in the epiphysis of the right hip. Profiles of uptake in the right and left hips superimposed for visual comparison; drawn line = left hip, dotted line = right hip.

B. Profiles of uptake in the right and left hips respectively.

C. Follow-up scan 6 weeks later, now showing an *increase* in isotope-uptake in the affected right hip.



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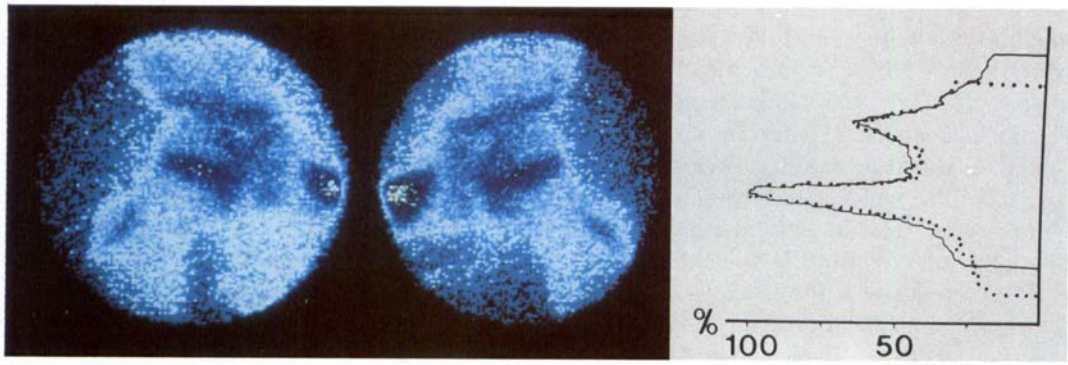

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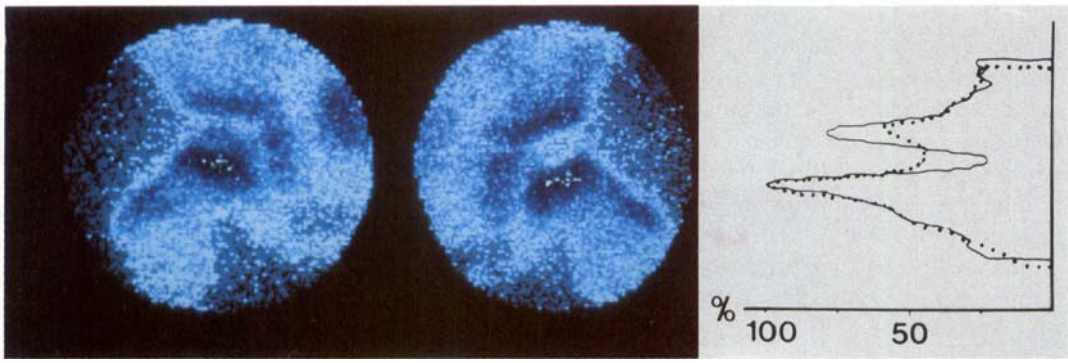
Figure 4. Case 2 with a transient ischaemia of the epiphysis of the left hip. This patient did not develop radiographic evidence of LCPD. Profiles of uptake superimposed as in Figure 3. Drawn line = left hip, dotted line = right hip.
A. Marked *defect* in isotope uptake in the epiphysis of the affected left hip on the initial scan.
B. Follow-up scan 6 weeks later, now showing an *increased* uptake in the affected left hip.



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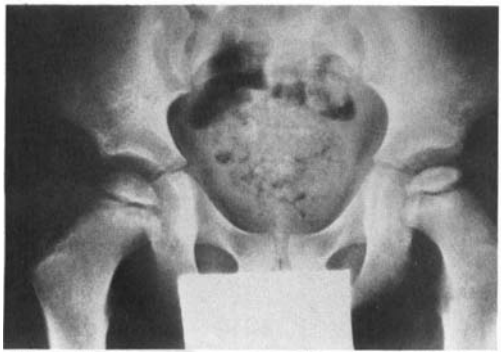

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Figure 5. Case 3 with left hip pain and initial normal radiographs but with future LCPD development. Profiles of uptake superimposed as in Figure 3. Drawn line = left hip, dotted line = right hip.
A. Scintimetry 10 days after the initial scan, showing a remaining defect of isotope uptake in the epiphysis of the affected left hip.
B. Radiograph 6 weeks after onset of symptoms, now revealing evidence of LCPD in the affected left hip.

Discussion

Most previous investigators have assessed scintigraphic results qualitatively. Quantitative assessment of femoral head involvement in LCPD was carried out by LaMont et al. (1981) using a pin-hole collimator. A good diagnostic capacity with regard to LCPD was demonstrated in spite of the methodological pit-falls in quantification with the use of the pin-hole collimator, which does, however, provide the resolution necessary for anatomical definition in children. LaMont et al. (1981) demonstrated that a reduction of isotope uptake over the PFE to ≤ 60 per cent was indicative of LCPD, which is in accordance with the one case in this material developing radiographic evidence of LCPD.

The correlation of the visual and quantitative estimation of PFE-uptake was good in this material (Figure 1). However, in the later stages of LCPD there is an increase in metaphyseal isotope-uptake (Bohr 1973, Danigelis et al. 1975, Bensahel et al. 1983). In the presence of this activity, due to an optical illusion, the epiphyseal activity may be visually underestimated. We believe therefore that quantitative assessment enhances the diagnostic accuracy, as demonstrated by Strömqvist (1983) in cervical fractures of the hip. The pin-hole technique makes direct visual comparison between the two hips difficult. In this respect the profile of interest provides a graphic "finger print" of the activity in the various anatomic regions of the hip, making possible a visual comparison of the uptake-pattern in the two hips.

Previous investigators have reported normal or diffusely increased scintigraphic uptake in transient synovitis of the hip (Ash et al. 1975, Danigelis et al. 1975, Fasting et al. 1978, Bensahel et al. 1983). By contrast, Kloiber et al. (1983) reported a series of 19 cases of transient synovitis with decreased PFE scintigraphy in six cases. After joint aspiration in these cases, isotope uptake 1–10 days later showed a return to normal, suggesting that the procedure had been therapeutic. Experimentally increased intra-articular pressure in puppies has been shown to produce a reduction of bloodflow or even infarction of the PFE (Woodhouse 1964, Lucht et al. 1983).

However, Sutherland et al. (1980) have reported two cases of transient synovitis with an initial PFE isotope defect that had spontaneously returned to normal at a follow-up scintigraphy 2 weeks later. Sty et al. (1983) reported on "a few" children with transient synovitis with an initial defect where joint aspirations were negative but in whom the isotope-uptake had returned to normal in a scan 24 h later.

We have found that among children presenting with the clinical picture of transient synovitis, there are a number of cases with transient ischaemia of the PFE. The concept of ischaemic episodes in the PFE raises interesting suggestions about the relationship between transient synovitis and LCPD and would also be in accordance with the histological findings of Inoue et al. (1976), suggesting repeated vascular insults in LCPD. The duration and/or severity of a single, or possibly repeated, episode of ischaemia of the PFE would determine the development of radiographic changes of LCPD.

The diagnostic accuracy of LCPD with the use of scintigraphy has been reported to be very high. (Danigelis et al. 1975, Fasting et al. 1978, Bensahel 1980, Sutherland et al. 1980, Tachdjian 1980, LaMont et al. 1981). However, this does not apply to the findings in early scintimetry in acute hip pain, where a typical PFE defect is potentially reversible and not followed by radiographic evidence of necrosis or clinical symptoms. Negative scintimetry should, however, effectively exclude LCPD.

With the very high diagnostic scintigraphic accuracy concerning LCPD in its early stage, preceding the diagnostic capacity of conventional radiography by months, scintigraphy should be performed in children with radiographically silent hip pain in order to rule out LCPD or, in cases with a PFE defect, to initiate further investigation.

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