Scintimetry in transient synovitis of the hip in the child

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Fifty-five consecutive children presenting with transient synovitis of the hip were examined with ^{99m}Tc-MDP scintigraphy and pin-hole collimator technique. Quantitative assessment was performed along a profile of interest across the hip joint. The criteria for the normal scintimetric pattern in the child's hip were established and the pathologic pattern of uptake in the acute phase, as well as in the follow-up after synovitis, was described.

A decrease in isotope uptake in the proximal femoral epiphysis was observed in 13 children. This was correlated with a reduced uptake in the growth-plate, indicating a disturbance of blood supply to these regions. A characteristic pattern of isotope uptake with duration of symptoms was observed: a decrease in uptake during the first week followed by rebound hyperemia within 1 month. One child developed osteonecrosis (Legg-Calvé-Perthes disease).

The etiology in Legg-Calvé-Perthes disease and its possible relationship with transient synovitis of the hip have for several decades been a matter of discussion, mainly because of similarities in epidemiology (Edwards 1952, Spock 1959). Animal experiments have shown that an increase in intracapsular pressure or direct surgical interruption of the blood supply to the proximal femoral epiphysis causes necrosis (Woodhouse 1964, Sanchis et al. 1973, Kemp 1981).

A characteristic pattern of epiphyseal isotope uptake in early Perthes' disease was described quantitatively by Lamont et al. (1981). Scintimetric studies in transient synovitis of the hip have revealed an absence or decrease in blood supply to the femoral epiphysis, which is potentially reversible following aspiration of an effusion which tamponades the epiphyseal vessels (Sutherland et al. 1980, Kloiber et al. 1983, Minikel et al. 1983, Wingstrand et al. 1985a).

We have defined the normal ^{99m}Tc-MDP scintimetric pattern in the asymptomatic hip and the pathologic patterns in transient coxitis of the child.

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Patients

Fifty-six children with the clinical diagnosis transient synovitis of the hip, i.e., acute onset of hip pain with restricted active and passive motion, were admitted for examination (Table 1). Thirty-nine were boys and 16 were girls aged 7 (2–13) years. The right hip was affected in 24 children, the left hip in 29, and 2 had bilateral symptoms. The duration of symptoms at the time of the first scintimetry was 18 (1–90) days. All the children had conventional radiography in AP and Lauenstein views. A clinical and radiographic follow-up was performed within 4–9 months. One patient who developed radiographic evidence of LCPD on follow-up was excluded. All the children were clinically and radiographically normal.

Methods

^{99m}Tc-MDP was injected intravenously in an age-related dose from 100 to 200 MBq. Anterior pin-hole images were obtained 3 to 4 hours after injection with the patient supine and the hip in neutral rotation. For palliative reasons the hip was slightly flexed with a pillow under the knee. A 4-mm aperture was used. The tip of the collimator

A	B	C	D	E	F	G	H	I
1	7	M	L	30	.8	1.18	.98	DG
1	7	M	L	100	1.42	1.18	1.38	IG, IA
2	7	M	L	1	.93	.99	1.07	
3	7	M	R	5	1.1	.38	1.12	DE
3	7	M	R	52	1.11	1.29	.97	IE
3	7	M	R	247	1.11	1.13	1.13	
4	6	M	R	15	1.07	1.21	1.17	IE
5	6	F	R	2	.82	.79	.87	DE
6	10	M	L	18	1.04	1.32	.96	IE
7	6	F	L	5	1.16	1.22	1.13	IE
8	6	M	R	3	1.1	1.15	.98	
8	6	M	R	44	.74	.89	1.01	R, DG
9	5	M	L	8	1.57	1.37	1.51	IG, IE, IA
10	6	M	L	5	.61	.65	1.06	DG, DE
10	6	M	L	30	.95	1.38	1.26	IE, IA
11	5	M	R	90	1.12	1.28	.84	IE
12	5	M	R	6	.75	.92	1.16	DG
13	5	F	R	11	1.04	.92	1.12	
14	5	M	L	22	.73	.88	1.01	DG
15	4	F	L	2	.86	.66	.73	DE, DA
15	4	F	L	48	.97	1.37	1.42	IE, IA
16	4	M	L	25	1.18	1.34	1.08	IE
16	4	M	L	92	1.11	1.36	1	IE
17	4	M	L	2	1.03	.82	1.07	
17	4	M	L	16	1.13	1.04	1.44	IA
18	3	F	R	6	.93	.93	1.11	
19	3	M	R	2	.76	.79	.79	DG, DE, DA
20	3	M	L	19	.78	.79	.74	DG, DE, DA
21	13	M	L	5	.86	.74	.97	DE
22	12	M	L	5	.65	1.04	1.11	DG
23	11	M	R	61	.94	1.59	1.11	IE
24	10	M	L	55	.95	.97	1.06	
25	9	M	R	35	1.2	1.12	1.18	
26	2	M	.	.	.	.	.	B
27	5	M	R	66	1.07	1.2	1.06	
28	6	M	R	12	1.14	1.38	1.26	IE, IA
29	8	F	L	5	.88	.79	.93	DE
30	8	F	L	2	.72	1.11	.96	DG
31	8	M	L	3	.57	.52	.81	DG, DE
32	8	F	R	15	.89	1.26	.83	IE
33	7	M	R	3	.87	1.21	1.21	IE, IA
34	8	M	L	4	.92	.54	.81	DE
34	8	M	L	45	1	1.04	1.02	
35	8	M	R	7	1.18	1.3	1.39	IE, IA
36	9	M	L	6	.96	.99	1	
37	9	M	L	34	.99	.98	1.29	IA
38	10	F	L	32	1.01	1.43	1.27	IE, IA
39	11	F	L	4	.81	.92	.92	
40	11	M	L	49	1.2	.99	.98	
41	11	F	L	4	1.21	1.09	.84	IG
42	9	M	R	34	1.15	1.29	1.23	IE, IA
43	3	F	R	5	.87	.83	.81	
43	3	F	R	138	.67	.65	.83	R, DG, DE
44	6	F	R	3	1.15	1.22	1.06	IE
45	11	M	R	10	1.23	.97	1.11	IG
46	8	M	R	22	1.08	1.29	1.08	IE
47	6	F	.	.	.	.	.	B
48	5	F	R	24	1.21	1.17	1.28	IG, IA
49	6	M	L	9	.88	.89	.95	
50	3	M	L	3	.7	.85	.88	DG
51	2	F	.	.	.	.	.	M
52	3	M	L	3	.91	.72	.9	DE
52	3	M	L	33	.92	.96	1.07	
53	4	M	R	10	1	1.19	1.12	
54	6	M	.	.	.	.	.	M
55	4	M	L	79	1.05	.91	.91	

A Case No.
B Age (y).
C. Sex.
D Affected side.
E Duration of symptoms at time of scintimetry (days).
F Isotope uptake ratio growth-plate/metaphysis in the affected versus nonaffected hip.
G Ratio epiphysis/metaphysis as in F.
H Ratio acetabular roof/metaphysis as in F.
I Comments: DG, DE, DA; Decrease in growth-plate, epiphysis and acetabulum isotope uptake. IG, IE, IA; Increase, respectively. M; Excluded due to movements. B; Bilateral symptoms. R; History of recurrent episodes of pain at follow-up.

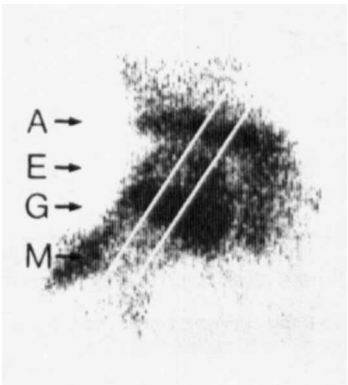


Figure 1. Pin-hole image of the right asymptomatic hip in Case 2 with the profile of interest along the axis of the neck of the femur perpendicular to the growth plate.
A acetabular roof,
E epiphysis,
G growth-plate
M metaphysis

touched the skin anteriorly, aiming at the growth plate (Figure 1). In 10 children, follow-up scintimetry was performed, in 1 child twice; and thus 66 pairs of pin-hole examinations were obtained. In 13 children (Cases 43–55) a field correction to evaluate the role of the geometric distorsion associated with the pin-hole collimator technique was employed.

Scintimetric data were computerized and analyzed as follows. A profile of interest was selected along the axis of the neck of the femur across the growth plate, epiphysis, joint space, and into the acetabulum perpendicular to the growth plate (Figure 1). The peak activities in the acetabular roof, epiphysis, and growth plate were related to the activity in the metaphyseal region defined as

the midpart of the neck of the femur (Figure 3). The profile ratios in the symptomatic hip were related to the corresponding ratios in the asymptomatic hip for individual correlation. Values beyond the normal range as defined by Deutsch et al. (1981), i.e. ± 20 percent, were considered abnormal. In patients with bilateral symptoms the criteria (mean ± 2 SD) established from the asymptomatic hips were employed. The Student's *t*-test and the *F*-test analysis of variance were used.

Two patients were excluded because they had moved during the examination.

Results

Analysis of the isotope uptake in the asymptomatic hips revealed a characteristic pattern (Table 1, Figures 1 and 3). The growth-plate activity (3.84, SD 0.78) was higher ($P < 0.001$) than the activity in the epiphysis (1.53, SD 0.4), or in the acetabulum (2.14, SD 0.54). The epiphyseal/acetabular junction was always distinct or there was even a dip in activity representing the joint cartilage. The epiphyseal uptake was lower than in the acetabulum ($P < 0.0001$). There was no difference with regard to sex or age. The use of field correction for geometric distorsion did not alter the results.

In the symptomatic hips a decrease in uptake in the femoral epiphysis was noted in 13 cases at the initial scintimetric examination; the duration from onset of symptoms was 5 (2–19) days in these children. In 15 children an increase in uptake was noted at the initial examination; the duration of symptoms in these children was 23 (3–90) days. A follow-up scintimetry was performed in 5 out of the 13 cases with decreased epiphyseal activity. Normalization occurred in 2 of these cases and increased activity in 3 (Figures 2 and 3).

A decrease in growth-plate activity was noted in 10 children at the initial scintimetric examination. Follow-up scintimetry in 2 of these showed a normalization or increase in growth-plate activity (Figure 4). The changes in epiphyseal and growth-plate activity were correlated ($P < 0.0001$).

An increase in activity in the acetabular roof was noted in 8 children at the initial scintimetric examination, and a decrease in 2 children. In Case 47 with bilateral symptoms, an increase in acetabular activity in the left hip was noted as judged by the criteria established from the asymptomatic hips.

Discussion

The vascular supply to the proximal femoral epiphysis changes with age (Trueta 1957, Ogden 1974). The epiphysis is supplied mainly via lateral, intracapsular branches emanating from the medial circumflex artery. In scintimetric studies, several authors have described a decrease in epiphyseal uptake in various conditions of hip joint disorders in children, such as transient synovitis, septic arthritis, and traumatic intracapsular bleeding (Sutherland et al. 1980, Kloiber et al. 1983, Minikel et al. 1983, Hasegawa 1985, Wingstrand 1986, Wingstrand et al. 1985a, 1987). This ischemia is potentially reversible either spontaneously or following hip joint aspiration (Kloiber et al. 1983, Wingstrand et al. 1985b), as is femoral head ischemia following hip joint tamponade in undisplaced fractures of the neck of the femur in the adult (Wingstrand et al. 1986). The common factor in these disorders may be the hazardous effect on blood circulation of an increase in intracapsular pressure as noted in transient synovitis of the hip, septic arthritis, juvenile chronic arthritis of the hip, as well as in undisplaced femoral neck fracture (Wingstrand et al. 1985b, Kaillio and Ryöppy 1985, Rydholm et al. 1986, Wingstrand et al. 1986, 1987). In patients

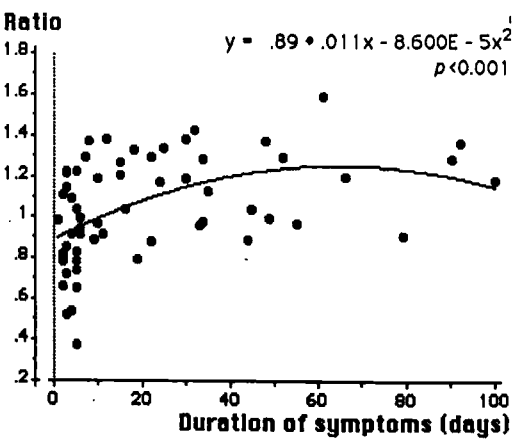
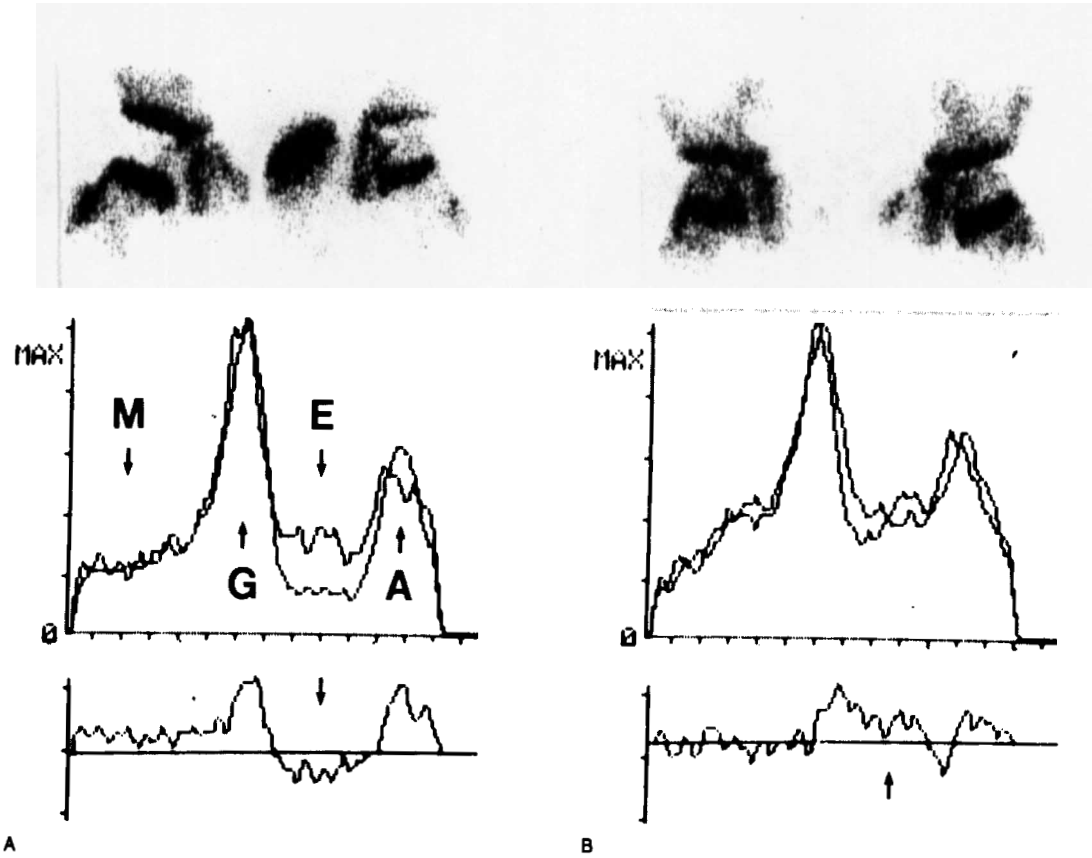


Figure 2. Isotope uptake ratio epiphysis/metaphysis in the affected versus nonaffected hip in transient synovitis.



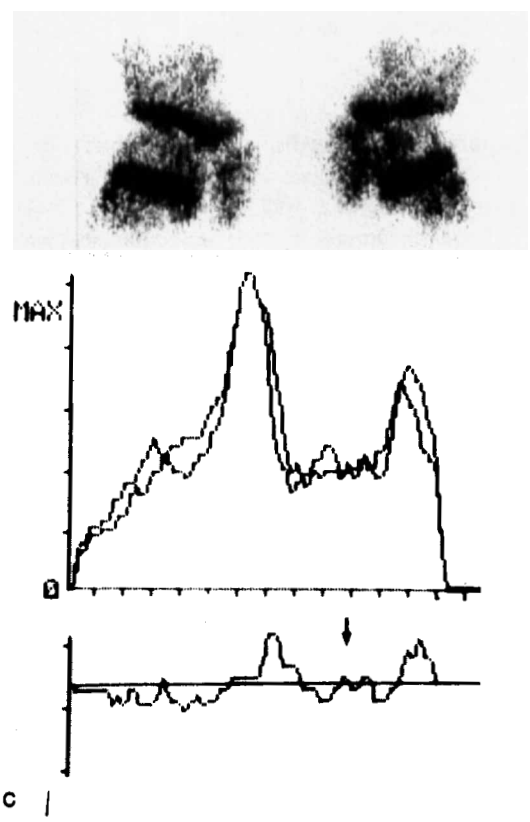


Figure 3. Profile scintimetry in Case 3.
A. Pin-hole image in the first examination (top). Profiles in the two hips superimposed (A acetabular roof, E epiphysis, G growth plate, M metaphysis) and absolute counts subtracted (below). There is a marked decrease in epiphyseal uptake in the right hip (arrow).
B. Follow-up examination 7 weeks later with rebound increase in isotope uptake in the epiphysis.
C. Second follow-up after 8 months with normalization of uptake.

with a decrease in epiphyseal isotope uptake, normalization and in some cases a rebound increase in uptake, as in this study, have been noted (Kloiber et al. 1983, Wingstrand et al. 1985a). A decrease in epiphyseal activity, most likely due to a decrease in blood flow, was noted in 13 children with a mean duration of symptoms of 5 days, whereas increased uptake was noted in 15 children with a mean duration of symptoms of 23 days. This is most likely due to a rebound hyperemia/hypermetabolism following an ischemic period, and cannot be explained by an increase in soft-tissue activity due to the synovitis around the hip, for this would also affect the region of reference

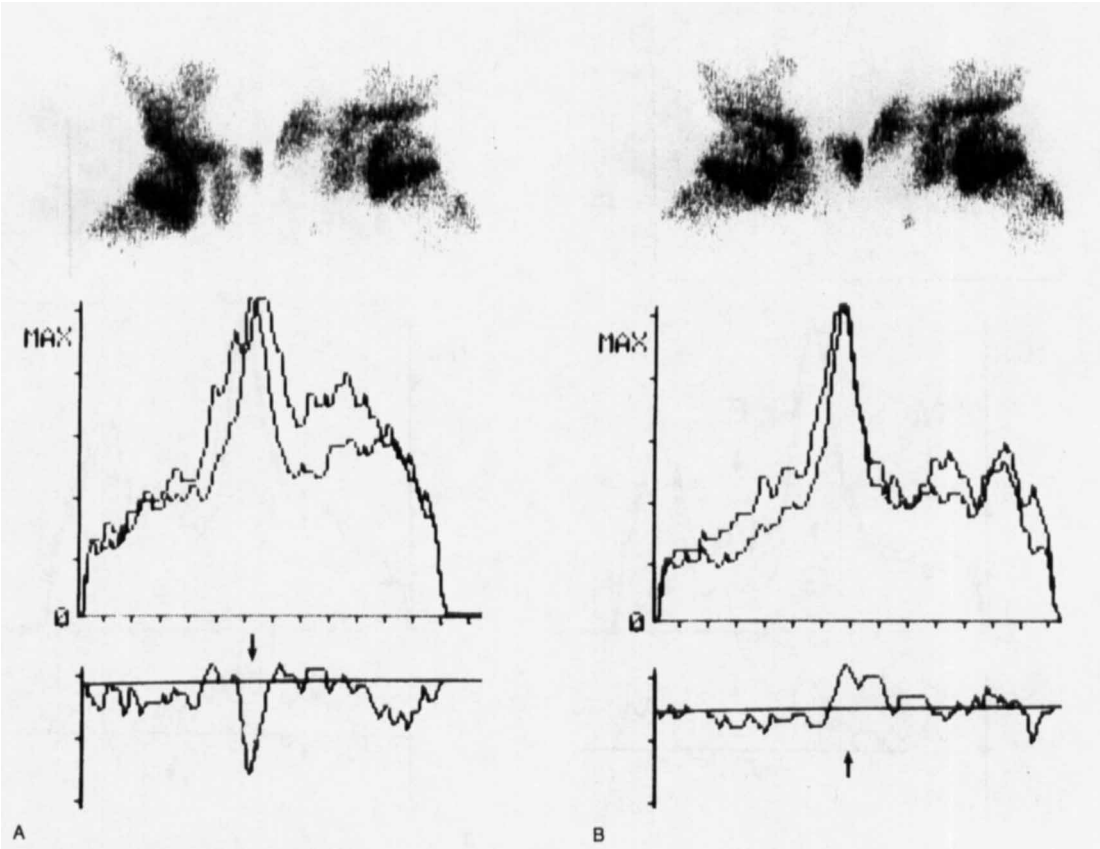


Figure 4. Profile scintimetry in Case 1.
A. At the first examination, there is a decrease in isotope uptake in the growth plate of the left hip (arrow).
B. At follow-up 3 months later, there is rebound increase in uptake.

situated intracapsularly. Also, it accords with the cartilage overgrowth and coxa magna development in this condition (Valderrama 1963, Anderson and Stewart 1970, Gershuni et al. 1978, Egund et al. 1987).

A reduced uptake in the growth plate was observed in 10 hips. This phenomenon has not previously been reported. However, in Figure 4 in the paper by Minikel et al. (1983), a patient with transient synovitis and epiphyseal ischemia is demonstrated where this phenomenon is obvious. Recently, reduced growth-plate activity has also been reported following synovitis induced in mongrel puppies (Hansen et al. 1985). This phenomenon may be explained by the fact that the proximal part of the growth plate, the location of the essential mechanism of chondrocyte proliferation, is also supplied via intracapsular vessels potentially vulnerable to tamponade (Trueta et al. 1957, 1960). This would also explain the growth-plate and metaphyseal engagement and growth disturbance observed in patients with transient synovitis and manifest Perthes' disease (Barnes 1980, Catterall et al. 1982, Wolinski et al. 1984).

Increased uptake in the acetabular roof was noted in eight hips, indicating hyperemia-hypermetabolism in this region, agreeing with the histologic findings of vascular proliferation (Adams 1963). It also accords with the acetabular roof overgrowth as shown radiographically following transient synovitis (Egund et al. 1987).

The peak activity in the various anatomic regions of the child's hip is easily defined, whereas conventional regions of interests may be difficult to localize optimally especially when studying the growth-plate and acetabular-roof uptake with its sharp and well-defined peak activity. Profile-scintimetry evaluation of the child's hip enhances the diagnostic accuracy and information concerning the vascular and metabolic status in the various anatomic regions of the hip.

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