

Intracapsular pressure in hip synovitis in children

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Scintimetry and intracapsular pressure recordings were performed in 10 painful hips in children. Maximum intracapsular pressures were recorded with the hip in extension or in 90° of flexion. Minimum pressures were recorded with the hip in semiflexion. Extremely high pressures were recorded in extension/maximum internal rotation. In 3 cases the

pressure exceeded the estimated systolic blood pressure. There was a close correlation between the volume of aspirated fluid and intracapsular pressure. In a case of septic arthritis, ischemia in the epiphysis was noted scintigraphically. This ischemia was reversed following decompression by aspiration.

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The vascular supply to the proximal femoral epiphysis is vulnerable to increased intracapsular pressure (Soto Hall et al. 1964, Kemp 1981, Wingstrand 1985a, Kallio et al. 1985a). Sonography is a reliable diagnostic tool in hip joint effusion in synovitis (Wingstrand 1986). Several experimental studies have shown that hip joint tamponade can cause ischemia and even necrosis of the proximal femoral epiphysis (Woodhouse 1964, Kemp 1981).

Our purpose was to investigate the relationship between increased intracapsular pressure and transient ischemia of the proximal femoral epiphysis in hip joint synovitis.

Patients and methods

Thirty-eight children with synovitis of the hip were examined consecutively with conventional radiography, sonography, and scintigraphy within a few days after the onset of symptoms. A sonographic difference in capsular distension of 1.0 mm or more was considered diagnostic for intracapsular effusion (Hasegawa et al. 1988).

Based on this criterion and a conventional radiographic examination, 20 patients were diagnosed as having transient synovitis, 2 as having septic arthritis, 2 as having Perthes' disease, and 1 as having post-traumatic chondrolysis.

Ten children underwent a preoperative scintimetric examination. In these hips the sonographic difference in capsular distension in the symptomatic versus the nonsymptomatic hip exceeded 5 mm. The intra-

capsular pressure was recorded, and the hip joint effusion was aspirated. Nine children had transient synovitis and 1 had septic arthritis (Case 8). The mean age was 7 (3-9) years, and 7 were boys (Table 1). The intracapsular pressure was measured using a transducer (Nippon Kodan Co., Tokyo) with the hip in maximum extension, maximum extension/internal rotation, and in various degrees of flexion.

Conventional AP and frog-leg pelvic radiographs were obtained at the time of admission and at the follow-up after a minimum of 1 year. Scintigraphy was performed within 2 days after admission using a high-resolution pin-hole collimator. A ratio was calculated between the uptake in the region of interest (ROI) in the proximal femoral epiphysis (PFE) in the symptomatic versus the nonsymptomatic hip.

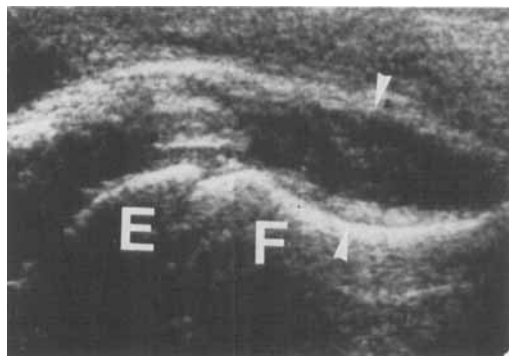


Figure 1. Ultrasonography in transient synovitis of the right hip joint (longitudinal scan of Case 1). Ultrasonographic joint space was measured between the two arrows. E = epiphysis, F = femoral shaft.

Table 1. Intracapsular pressure in 10 children with hip synovitis

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	8	M	R	10	7.8	4.0	2.1	1.6	1.9	1.9	2.4	2.9	12.7	2.9	5.0	1.13
2	6	F	L	2	6.1	4.9	3.1	2.0	1.7	2.4	3.6	8.8	20.1	11.9	3.0	1.08
3	9	F	L	1	6.0	7.1	4.8	5.2	4.4	6.3	6.7	8.9	21.2	14.8	6.0	1.05
4	3	M	L	3	5.0	5.5	2.5	1.6	1.5	1.7	1.6	2.0	10.7	10.4	2.1	1.11
5	8	M	L	2	5.3	3.7	2.3	1.9	1.9	2.1	2.3	2.5	10.1	4.3	1.8	0.98
6	5	M	R	1	5.0	7.3	3.3	2.3	2.9	3.3	4.7	6.0	12.4	7.7	2.3	1.10
7	7	M	R	3	5.6	6.9	3.1	2.9	3.5	3.3	4.4	5.2	10.4	6.0	2.0	0.99
8	10	M	L	5	7.2	13.7	4.3	4.7	4.8	5.5	7.7	10.4	32.4	10.8	10.5	0.40 ^a
9	3	M	L	2	5.2	5.2	2.3	1.4	1.3	1.5	1.4	1.8	10.5	10.0	2.5	1.05
10	11	F	L	3	5.0	7.2	6.8	4.4	4.5	5.5	6.0	7.5	15.0	11.8	2.8	1.08

A Patient no.

B Age (years)

C Sex

D Left/right symptomatic hip

E Duration of symptoms at the time of aspiration (days)

F Sonographic joint space (difference from normal hip, mm)

G-M Intracapsular pressure (kPa) in extension (flexion of 0°), flexion of 15°, 30°, 45°, 60°, 75°, and 90°, respectively

N-O Intracapsular pressure in maximum internal and external rotation (kPa)

P Aspirated fluid volume (mL)

Q Scintimetric ratio in the affected/nonaffected femoral epiphysis.

^a Septic arthritis (second scintimetric ratio = 1.30)

Scintimetric data were obtained 3 hours after the intravenous injection of ^{99m}Tc MDP. In 1 patient (Case 8), follow-up scintimetry was performed after a cold lesion had been observed in the proximal femoral epiphysis during the first examination.

The Student's *t*-test was used in the statistical analyses.

Results

Maximum intracapsular pressures were recorded with the hip in extension: 6.6 kPa (SD 2.8). Following only slight flexion, the intracapsular pressures were reduced; minimum pressures were recorded within 15–45° of flexion: 2.8 kPa (SD 1.4), whereas pressures increased again when flexion exceeded 60°. In 2 cases (Cases 2 and 3) the intracapsular pressure with the hip in 90° of flexion exceeded the pressure in extension. Maximum pressures were recorded with the hip in respectively extension and internal rotation: 15.6 kPa (SD 7.2) and 9.2 kPa (SD 3.7). In 3 cases (Cases 2, 3, and 8) the intracapsular pressure with the hip in maximum extension/internal rotation exceeded the estimated systolic blood pressure.

The mean aspirated volume of the effusion was 3.8 mL (SD 2.7). There was a correlation between the volume of aspirated fluid and intracapsular pressure in extension ($P < 0.05$), but there was no correlation between the capsular distension, as measured sonographically, and the volume of aspirated fluid.

The mean scintimetric ratio was 1.0 (SD 0.2). In 1 case (Case 8), there was a significant decrease in isotope uptake in the proximal femoral epiphysis; the ratio was 0.40 (Figure 2), and the uptake in the acetabulum was increased. The volume of aspirated fluid was 10.5 mL; the maximum intracapsular pressure in extension and in extension-internal rotation was 13.7 and 32.4 kPa, respectively. *Staphylococcus aureus* was cultured from the fluid. The follow-up scintimetry 3 days after aspiration showed a ratio of 1.30, indicating rebound hyperemia (Figure 3).

The intracapsular pressure following aspiration was below 1.0 kPa in all the patients. A radiographic follow-up more than 1 year after the onset of symptoms showed no necrosis of the proximal femoral epiphysis in these children.

Discussion

Wingstrand et al. (1985b) have reported in detail about the relationships between the pressure and the position of the hip in transient synovitis. The aspirated volumes were 2.7–8.1 mL and the intracapsular pressures in extension were 7.6–17.3 kPa, quickly reduced to 0.0–3.7 kPa with the hip in 45° of flexion. Similar findings were reported by Kallio et al. (1985).

According to Trueta (1957) and Ogden (1974), the blood supply to the PFE is mainly derived from the medial circumflex artery penetrating intracapsularly into the lateral aspect of the joint. There is no



Figure 2. Scintigrams with high resolution collimeter in septic arthritis of the left hip (Case 8). Left hip indicated cold lesion in PFE (uptake ratio = 0.40). Medial acetabular wall showed hot lesion, probably due to synovial proliferation.

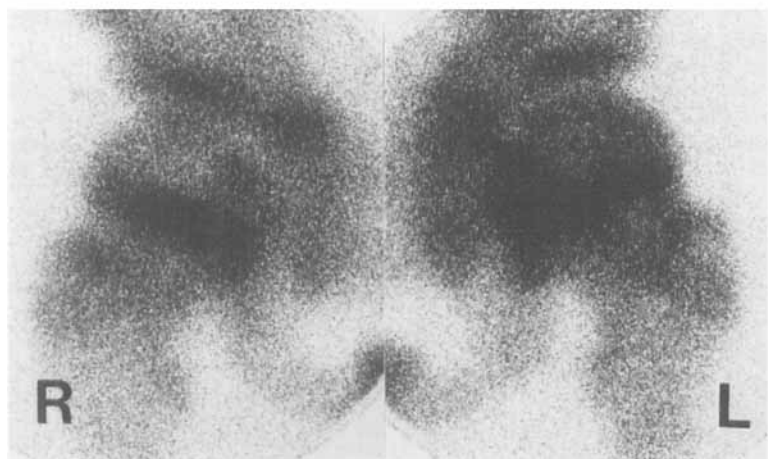


Figure 3. Second scintigrams (Case 8) 3 days after aspiration. Left hip indicated rebound hyperemia in PFE (uptake ratio = 1.30).

intraarticular blood supply crossing the growth plate and only a very small contribution through the vessels in the ligamentum teres. Therefore, the blood supply to the PFE is extremely vulnerable to an increased intracapsular pressure (Woodhouse 1964, Lucht et al. 1983).

Several scintigraphic studies have demonstrated transient ischemia of the PFE in transient synovitis and in septic arthritis (Kloiber et al. 1983, Minikel et al. 1983, Wingstrand et al. 1985a, 1987, and Hasegawa et al. 1988). Case 8 in this study is the fifth case of reversible transient ischemia following aspiration quoted in the literature.

Traumatic hip tamponade with a decreased isotope uptake in the head of femur was also described in undisplaced femoral neck fractures (Wingstrand et al. 1986, Melberg et al. 1986).

If the intracapsular pressure exceeds the venous pressure in the vessels draining the PFE, a corresponding decrease in perfusion pressure gradient and thus blood flow to the PFE would result, up to a point where perfusion pressure would be insufficient and necrosis of the PFE would occur. This has been shown experimentally by Woodhouse (1964), Kemp (1981), and Lucht et al. (1983). However, flexion of the hip joint reduces the intracapsular pressure substantially. Intermittent flexion of the hip restores blood supply and prevents necrosis. Aspiration, and thus decompression in cases with marked effusion, should reduce the risk of irreversible ischemic damage to the proximal femoral epiphysis.

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