

Intracapsular pressure in transient synovitis of the hip

Fourteen consecutive children with symptoms of transient synovitis of the hip were examined with sonography regarding intracapsular effusion, with scintimetry regarding blood-flow in the proximal femoral epiphysis (PFE) and with intracapsular pressure recording and aspiration. All patients had an intracapsular effusion. Intracapsular pressure was found to depend on the position of the hip. The mean pressure with hips in extension and inward rotation was 22.6 kPa (170 mm Hg) whereas in 45° of flexion it was 2.3 kPa. In two cases scintimetry demonstrated reduced blood flow to the PFE; after aspiration, isotope uptake returned to normal, indicating that increased intracapsular pressure has a harmful effect on circulation to the PFE.

Children with transient synovitis should be treated with the hips in 45° of flexion to reduce intracapsular pressure. Forcing the hip in extension causes a risk of ischaemia of the PFE.

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The blood supply to the proximal femoral epiphysis (PFE) in this age group is mainly derived from the lateral capsular branches of the medial circumflex artery, with no contribution across the growth plate and a very small contribution via vessels in the ligamentum teres (Trueta 1957, Theron 1980). Vessels are located intracapsularly and thus theoretically exposed to an increase in intracapsular pressure.

It has been shown experimentally in puppies (Woodhouse 1964, Lucht et al. 1983), and suggested clinically in intracapsular fractures and septic arthritis (Minikel et al. 1983) and in transient synovitis (Kloiber et al. 1983), that an intracapsular haematoma or effusion with ensuing increase in intracapsular pressure compromises blood-flow to the PFE. Conventional radiography of the hip in these cases offers little information about intracapsular effusion (Brown 1975), whereas sonography has proved to be an accurate diagnostic tool in this respect (Jäppinen et al. 1984, Wingstrand et al. 1985a).

We have identified intracapsular effusion and measured the pressure in transient synovitis with regard to the position of the hip, to possible circulatory effects on the PFE and to the effect of aspiration.

Patients

Fourteen patients with the clinical findings of transient synovitis and without radiographic evidence of any other hip disorder were included in the study. Twelve were boys. The mean age was 6.4 (3-12) years. The duration of symptoms at the time of aspiration was 41 (24-144) h. The right hip was affected in six patients, and the left hip in eight patients. One patient (Case 9) had Legg-Calvé-Perthes' disease in the *right* hip. This diagnosis had been radiographically and scintimetrically verified 5 months prior to the episode of synovitis in the contralateral *left* hip, which was radiographically normal. Case 7 had a non-ossifying fibroma in the neck of the femur in the left *non-symptomatic* hip. For further clinical and laboratory data, see Table 1.

Methods

On admission to hospital the patients were placed in bed and the hips were freely moveable, allowing the patient to adopt the least painful position. All patients were examined with conventional radiographs in AP and frog-leg views.

Sonography. Sonography, using real-time equipment (Diasonics DRF 12, 7.5 or 10 MHz transducer), was performed in all patients in a sagittal plane along the axis of the neck of the femur with the patient supine

Table 1. Observations in 14 patients with transient synovitis of the hip

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	9	M	L	6	4	37.5	1.18		4.5	3.3	yes	11.6	18.6	9.7	2.0
2	12	M	L	1	5	36.4	0.93		5.0	5.5	no	11.0	24.2	23.3	1.9
3	4	M	R	1	4	36.8		1.03	4.3	2.8	no	12.1	21.3	7.8	0.0
4	6	M	L	1	15	38.2		1.08	5.0	1.6	no	14.5	21.4	7.4	2.5
5	3	M	R	2	3	37.6	1.02		4.6	0.5	no	10.5	16.0	8.6	2.0
6	8	M	R	2	7	37.5		1.26	6.8	5.5	no	17.3	28.6	25.9	2.0
7	10	M	R	2	7	37.5	0.82	1.09	8.1	7.5	yes	11.8	21.9	13.7	3.3
8	6	M	L	1	3	38.1		1.35	5.4	2.8	yes	14.9	26.3	20.0	4.0
9	4	M	L	1	5	37.0	0.80	1.02	2.7	3.5	yes	7.6	16.0	18.0	0.7
10	4	M	L	1	7	36.9	0.99		2.7	2.0	no	17.3	22.6	15.7	2.3
11	5	M	R	1	3	37.2		1.23	5.0	6.0	no	11.4	18.0	8.3	2.7
12	4	M	R	2	3	37.0		0.95	5.0	5.0	no	13.0	18.6	10.6	2.7
13	4	F	L	2	13	37.0	0.89		5.3	5.0	yes	16.6	45.9	30.6	3.7
14	6	F	L	1	4	37.6	1.13		4.7	1.5	no	11.4	16.6	10.9	2.4

A = Patient no; B = Age (years); C = Sex (M = male; F = female); D = Left/right symptomatic hip; E = Duration of symptoms at time of aspiration (days); F = ESR (mm/h); G = Body temperature (°C); H = Pre-operative scintimetric ratio (symptomatic/non-symptomatic proximal femoral epiphysis); I = Postoperative scintimetric ratio as in H; J = Preoperative sonography; capsular distension (mm); K = Aspirated volume (ml); L = Previous episode of transient synovitis; M-P = Intracapsular pressure in extension neutral position, extension inward rotation, extension outward rotation and in flexion 45° respectively (kPa).

and with the hips in a neutral position (Figure 1). The ventral distension of the capsule along the neck of the femur was determined and compared to the corresponding measurement in the contralateral hip. Patients were followed with serial sonography after aspiration.

Scintimetry. In eight patients scintimetry was performed prior to, and in six patients after aspiration. In two patients scintimetry was repeated after aspiration. 100–200 Mbq of ^{99m}Tc-MDP was injected intravenously in an age-related dose. Images were obtained 3–4 h later, using an ultra-high resolution parallel-hole-collimator in AP views. Images were evaluated quantitatively as a ratio between the activity in a region of interest (ROI) in the lateral part of the PFE and the activity in a corresponding ROI in the contralateral non-symptomatic PFE.

Intracapsular pressure. All patients had general anaesthesia and were placed supine with the hips freely moveable. A 1.2 mm epidural needle and a 2 ml syringe were connected via a 3-way stop-cock to a piezoelectric pressure transducer. The system was filled with saline and calibrated before and after the procedure. Readings were obtained graphically and digitally on an oscilloscope. With the aid of an image intensifier, the needle was introduced antero-laterally, aiming at the ventral, mid-part of the neck of the femur. The needle was introduced only once. The intracapsular position of the needle point was secured by observing the sudden rise in pressure on

the oscilloscope when penetrating the capsule and when aspirating the joint at the end of the procedure. Pressure was recorded with the hip in the following positions: 1) extension and neutral position, 2) extension and maximum inward rotation, 3) extension and maximum outward rotation, and 4) with the hip in 45° of flexion. Aspiration was performed in

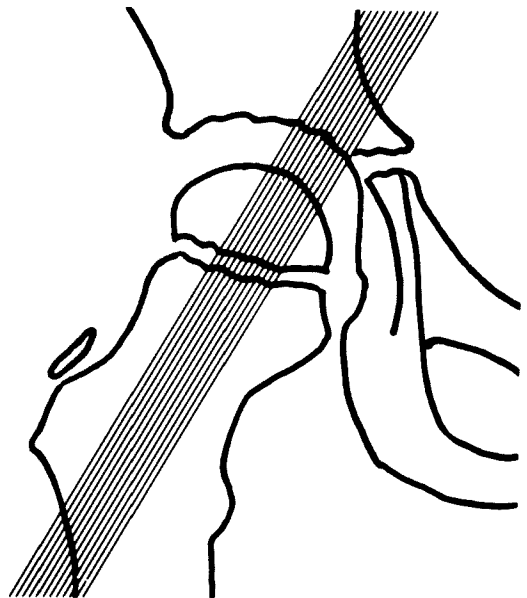


Figure 1. Sonographic sectioning in a sagittal plane along the axis of the neck of the femur.

steps with the hip in extension and neutral position, and a pressure/volume-graph describing the capsular compliance in the individual case could thus be drawn. Pressures are presented in kPa (7.5 mm Hg). Patients were kept in bed for 4 days after aspiration and were then discharged with restricted physical activity for another week. Serial clinical and sonographic follow-up was performed after discharge.

Results

Conventional radiographs were all normal with regard to the symptomatic hips.

Sonography. All patients had intracapsular effusions as diagnosed sonographically. Capsular distension was 2.7–8.1 mm (mean \pm SD = 5 mm \pm 1) (Table 1). Case 9 was excluded due to bilateral disease. Serial postoperative sonographies in general showed a recurrence of the effusion, in three patients capsular distension even equalled or exceeded initial findings within 5 days, whereas in two patients there was no recurrence postoperatively. Further postoperative development with regard to capsular distension is illustrated in Figure 2. A positive correlation was found between capsular distension and volume of fluid aspirated ($r = 0.6$).

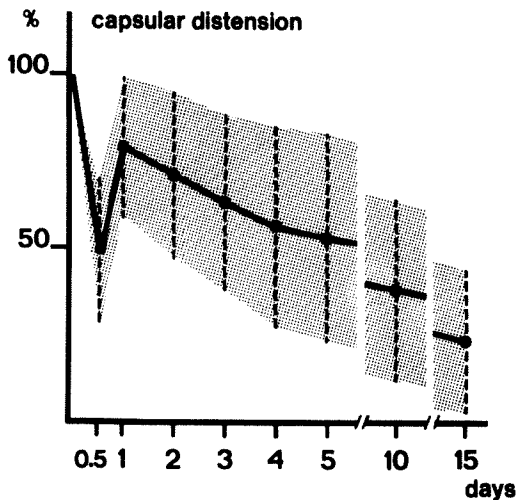


Figure 2. Serial sonography following aspiration in 13 patients. Capsular distension given as a percentage \pm SD of preoperative value.

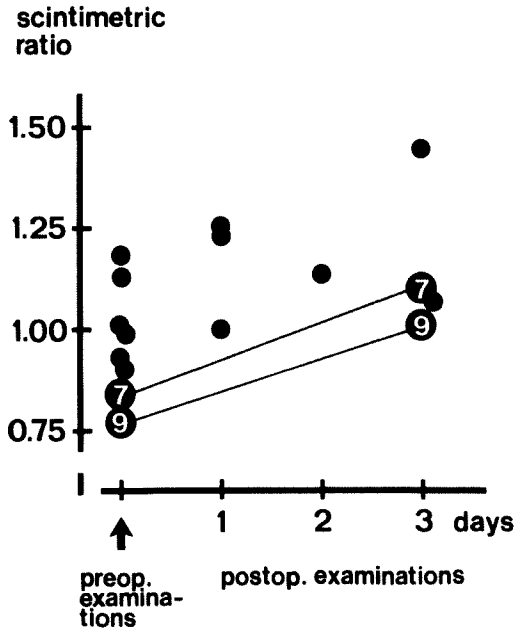


Figure 3. Scintimetric ratios (symptomatic/non-symptomatic PFE) pre- and postoperatively. In Cases 7 and 9 there was a photopenia in the PFE, reversible following aspiration.

Scintimetry. Eight patients were examined prior to aspiration. In three of these patients the scintimetric ratio symptomatic/non-symptomatic PFE was >1.0 , i.e. symmetric or increased isotope-uptake in the symptomatic side. In five patients the ratio was <1.0 , in two of these patients (Cases 7 and 9) there was a marked decrease, ratios being 0.82, and 0.80, respectively, indicating a disturbance of blood supply to the PFE (Table 1). Follow-up scintimetry 3 days after aspiration revealed ratios of 1.09, and 1.02, respectively, i.e. a restitution of blood supply to the PFE (Figure 3). Cases 7 and 9 with transient photopenia in the hips are illustrated in Figures 4 and 5, respectively.

Intracapsular pressure. The presence of intracapsular effusion was verified in all patients on aspiration. Intracapsular pressures with the hips in various positions as described above are listed in Table 2. Maximum intracapsular pressure was recorded with the hips in extension and inward rotation, and minimum pressure in flexion 45° . After aspiration, which was performed with the hips in extension and neutral position, pressure was 0 kPa. In some cases a

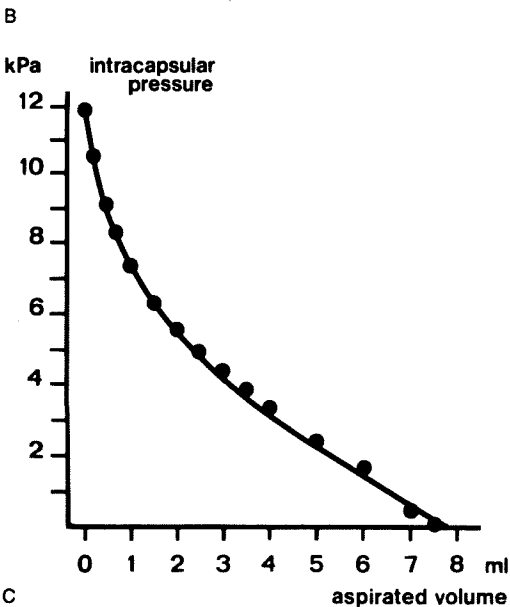
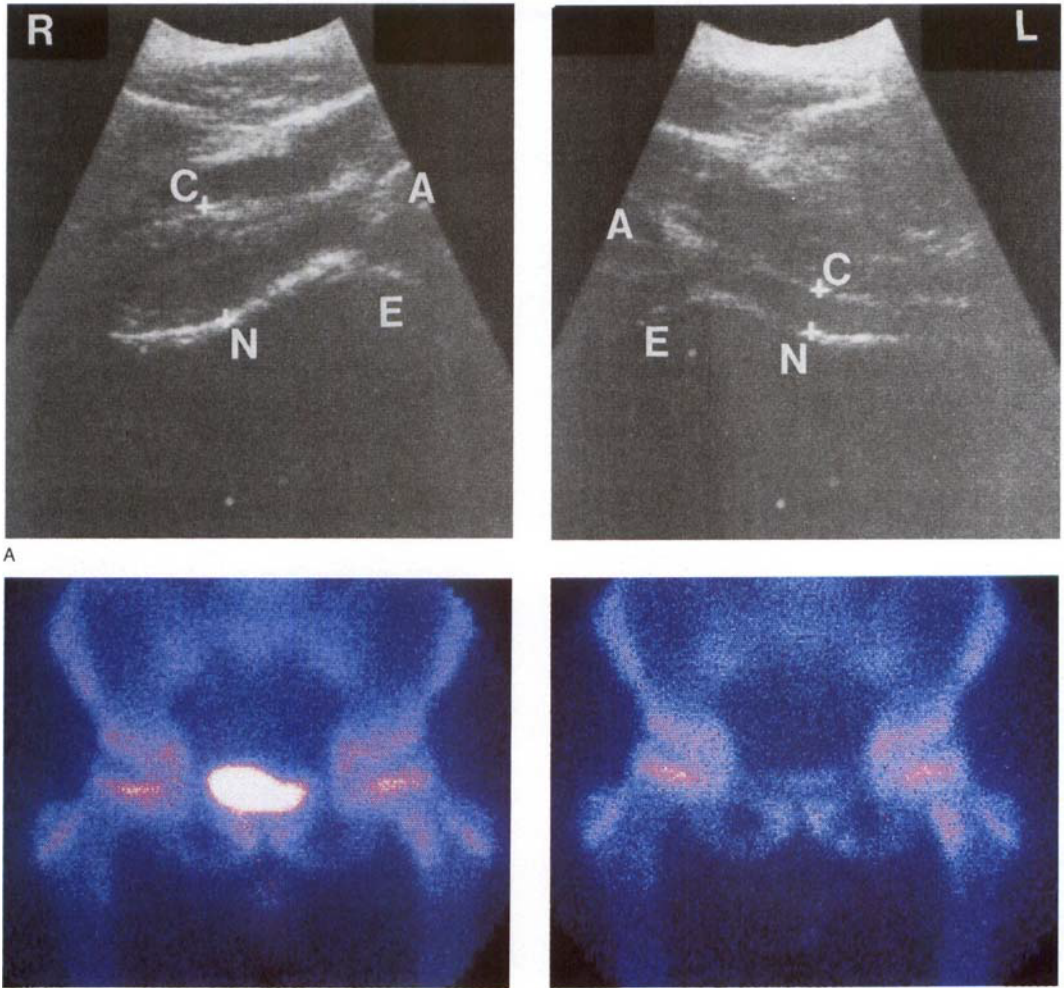
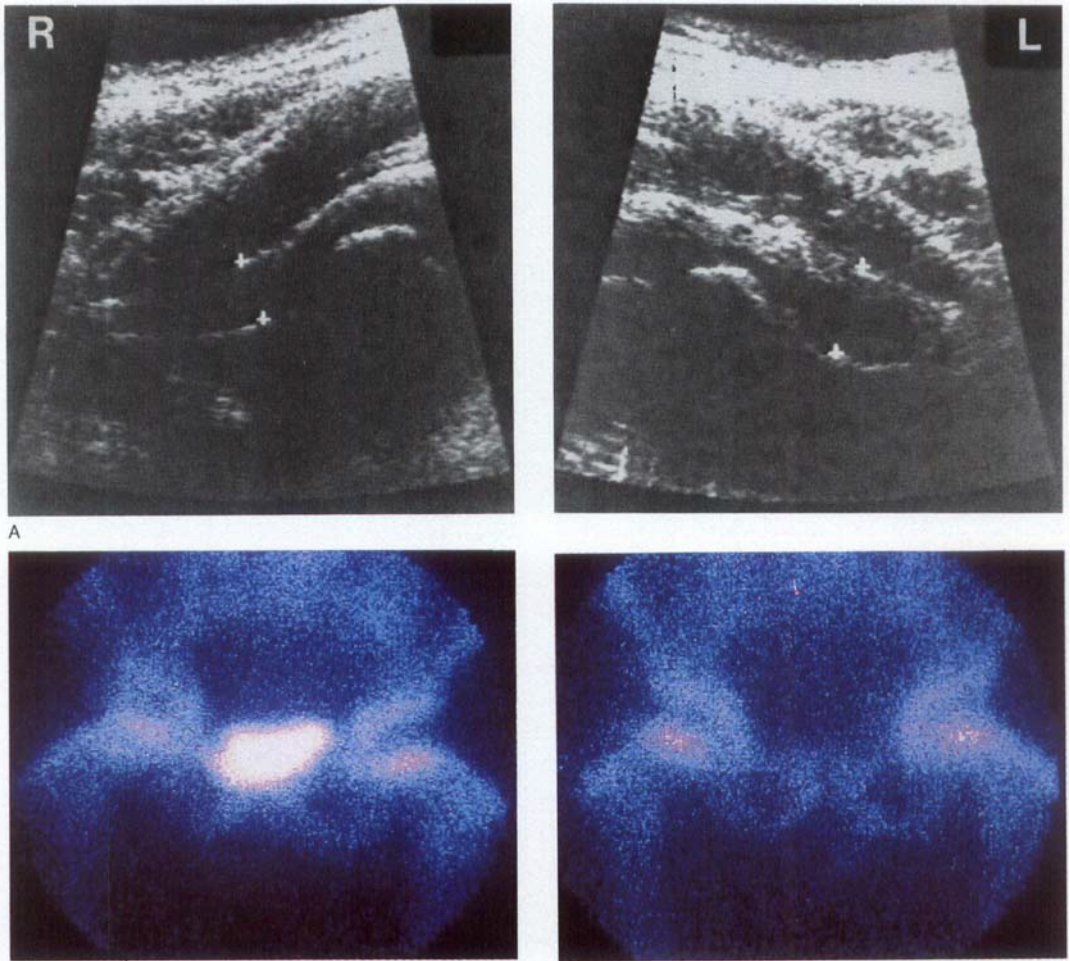


Figure 4. Case 7 with a transient photopenia in the right proximal femoral epiphysis (PFE).

A. Preoperative sonography of the right (R) symptomatic hip with a capsular distension of 8.1 mm as compared to the non-symptomatic left hip (L). Epiphysis (E), neck of femur, ventral aspect (N), acetabular labrum (A) and joint capsule (C).

B. Preoperative scintimetry with photopenia of the PFE in the right hip (left) as compared to restitution in uptake following aspiration (right). (This patient also has a non-ossifying fibroma with increase in isotope uptake in the neck of the femur of the non-symptomatic left hip.)

C. Volume/pressure-reduction-graph in this patient with an aspirated volume of 7.5 ml.



B
 Figure 5. Case 9 with a transient photopenia in the left proximal femoral epiphysis (PFE).
 A. Preoperative sonography of the left (L) symptomatic hip with a capsular distension of 2.7 mm as compared to the right hip (R).
 B. Preoperative scintimetry with photopenia of the PFE in the left hip (left) as compared to restitution in uptake following aspiration (right).

slight increase (<1.3 kPa) was noted in extension and maximum inward rotation after aspiration; other positions of the hip did not increase the intracapsular pressure after aspiration, but in flexion there was a slightly negative pressure in a few cases.

From the pressure/volume-graphs (Figure 4C), capsular compliance could be calculated in each patient. Within the range 0–8 kPa (0–60 mm Hg) compliance varied from 0.05 to 0.85 ml/kPa (mean ± SD = 0.34 ± 0.22) (Figure 6).

A positive correlation was found between compliance and age of the patient ($r = 0.6$), but, as could be expected with regard to variations in capsular compliance, there was no

correlation between volume and pressure ($r = 0.04$), nor between pressure and age of the patients ($r = 0.1$). Mean aspirated volume was 3.8 ± 2 ml (0.5–7.5 ml).

Following aspiration, the patients experi-

Table 2. Intracapsular pressure in various positions of the hip

Position of hip joint	Intracapsular pressure (kPa)	
	(min–max)	(mean ± SD)
Extension, neutral	7.6–17.3	(12.9±2.8)
Extension, inward rotation	16.0–45.9	(22.6±7.7)
Extension, outward rotation	7.4–30.6	(15.0±7.5)
Flexion 45°	0.0– 4.0	(2.3±1.1)

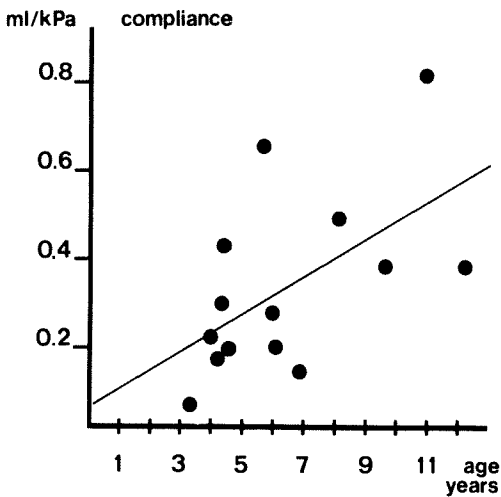


Figure 6. Capsular compliance (ml/kPa) in the range 0–8 kPa (0–60 mm Hg) in the 14 patients related to age.

enced marked relief of pain and an increase in active and passive motion. In all patients symptoms subsided completely within 2 weeks. Cases 7 and 9 have had normal radiographic follow-up 4 and 6 months respectively after this episode, and have had no clinical symptoms.

Discussion

Animal studies with experimentally induced hip joint tamponade have shown the development of necrosis or decreased blood circulation in the PFE. Intracapsular pressures of the magnitude noted in this series should accordingly be sufficient to cause ischaemia in the PFE due to vascular occlusion (Woodhouse 1964, Kemp 1981, Lucht et al. 1983).

Previous reports of intracapsular pressure in transient synovitis have been made by Soto-Hall et al. (1964), where pressures of 68 and 78 mm Hg (9.1 and 10.4 kPa) were noted in two patients with hips in neutral position and by Kloiber et al. (1983) who noted pressures of 22–66 mm Hg (2.9–8.8 kPa) in eight patients. However, as shown here, intracapsular pressure in these patients is very much dependent on the position of the hip joint. In extension, a significant rise in intracapsular pressure, theoretically well above the hazardous level, is

produced. This could explain the findings in two of our cases with a decrease in isotope uptake in the PFE, reversible following aspiration. One of these patients (Case 9) is of special interest since, to our knowledge for the first time, he demonstrated an episode of transient ischaemia in the PFE in a patient with manifest Legg-Calvé-Perthes' disease in the contralateral hip.

Previous isotope studies in transient synovitis have reported a normal or increased uptake in the PFE (Ash et al. 1975, Danigelis et al. 1975, Fasting et al. 1978, Bensahel et al. 1983). However, more recent studies have shown a proportion of these patients to have a temporary decrease in isotope uptake, suggesting a disturbance of blood supply to the PFE. This ischaemia has either been spontaneously reversible (Wingstrand et al. 1985b) or following joint aspiration (Kloiber et al. 1983, Minikel et al. 1983) without subsequent radiographic evidence of Legg-Calvé-Perthes' disease.

If these children are allowed free movements of the hip, as in this series, they only intermittently adopt an unfavourable position, i.e. in extension. This would explain why scintimetry does not in all cases reflect high intracapsular pressure; in flexion, pressure falls drastically to a possibly harmless level and thus the "mean" position of the hip during the 3–4 h from injection of the isotope to registration would determine the scintimetric outcome, as would the duration of symptoms at the time of scintimetry.

The duration and/or severity of a single or repeated episode of ischaemia of the PFE would determine the development of irreversible damage and thus radiographic development of LCPD. This concept of ischaemic, possibly repeated, episodes in the PFE due to intracapsular tamponade would be in accordance with the histologic findings of Inoue et al. (1976), suggesting repeated vascular insults in the development of LCPD.

Patients with transient synovitis of the hip should be immobilized with the hip in 45° of flexion to reduce intracapsular pressure. In patients with scintimetric evidence of ischaemia in the PFE, aspiration may reconstitute circulation.

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