Hemarthrosis after femoral neck fracture fixation

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In 34 femoral neck fractures, CT was performed within 1–32 days after internal fixation. All the cases except one showed an increased distance between the femoral neck and the anterior aspect of the joint capsule as compared with the intact side, indicating varying degrees of hip joint effusion and/or synovitis. Hip joint aspiration in 11 patients revealed increased intracapsular pressure varying between 10 and 112 mmHg and volumes of aspirated joint effusion up to 23 ml. Pain relief and increased joint motion after drainage of the intracapsular effusion was observed in 3 patients whose postoperative mobilization was facilitated.

Hip joint tamponade has been suggested as a contributory etiologic mechanism in necrosis of the femoral head after femoral neck fracture (Soto-Hall et al. 1964, Calandruccio and Anderson 1980, Deyerle 1980). This mechanism has been confirmed in animal studies (Woodhouse 1964, Tachdjian and Grana 1968, Launder et al. 1981), but not in man. Recently, however, a number of cases with traumatic hip joint bleeding, high intracapsular pressure, and ischemia of the femoral head have been diagnosed at our hospital (Wingstrand et al. 1986). In displaced fractures of the femoral neck, the joint pressure recorded in previous investigations has varied between 0 and 20 mmHg (Soto-Hall et al. 1964, Melberg et al. 1986), although reduced femoral head vitality is four to five times more common in displaced than in undisplaced fractures (Strömqvist and Hansson 1984).

We have correlated CT and intracapsular pressure measurements of hip joint effusion after femoral neck fracture fixation with radionuclide scintimetry of femoral head vitality.

Patients and methods

During the period January to June 1985, 88 patients were admitted and operated on (hook-pinning, Hansson 1982) for fracture of the femoral neck. Staff and technical capacity allowed us to examine only 34 patients (23 females and 11 males). The mean age was 78 (57–92) years.

The preoperative fracture displacement was classified from AP and lateral radiographs according to Garden (1961). Postoperative fracture displacement was classified in a three-graded scale: 0 = no displacement, 1 = no interruption of cortical contact, but slight compression medially, laterally or dorsally, 2 = fracture displacement and cortical interruption.

Computed tomography (CT) of the hips was performed 1–32 days after surgery using the Toshiba TCT 80 B, with a slice thickness of 5 mm. Three to four scans along the femoral neck and head were obtained without use of target scans. The distance between the ventral aspect of the ileofemoral ligament (capsule) and that of the femoral neck was measured directly on the viewing console using a window level and width of 50–100 and 400, respectively (Egund et al. 1986). The difference in distance between the fractured and normal side was interpreted as capsular distension (Figure 1).

Scintimetry with ^{99m}Tc-MDP was performed in 30 patients 1–3 weeks after femoral fracture fixation. The isotope activity was recorded with a gamma camera with a large field of view collimator 3–5 hours after the intravenous injection of 330–370 MBq. Regions of interest were selected over the femoral head of the fractured and intact sides (Strömqvist 1983), and a femoral head ratio fracture/intact side was determined (normal value 1.0).

Within 20 hours from the CT examination, hip

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joint aspiration was performed under local anesthesia with the patient supine. An anterolateral approach was used with a 1.4-mm epidural needle connected via a saline-filled closed system to a piezoelectric pressure transducer. Pressure was recorded graphically and digitally on an oscilloscope. In the 11 last patients the hip joint was aspirated after the pressure had been recorded.

Results

The evaluation by CT was disturbed by marked beam-hardening artefacts from the metal pins; and with the exception of 9 hips, it was not possible with certainty to distinguish between effusion and capsular swelling (Figures 1 and 2). The degree of capsular distension, easy to determine in every case investigated, was a mean 3.8, SD 2.4 (0.0–9.5) mm. No correlation between capsular distension and postoperative fracture position was observed (Table 1). There was, however, a difference in capsular distension between the 26 Garden Stages I to III fractures (n 26) and the eight Stage IV fractures (n 8). In 9 of the 13 Stage I fractures, peroperative aspiration of the hip joint was performed. The postoperative capsular distension of these was 4.4 (1.4–11) mm.

At scintimetry, eight hips had femoral head ratios fractured/intact side between 0.6 and 0.9 – seven of them with displaced fractures. No correlation between capsular distension and femoral head vitality was observed (Table 2).

Table 1. Capsular distension (SD) related to preoperative and postoperative fracture displacement in 34 patients with cervical hip fracture

Postop[a]	Preop[b]				Capsular distension (mm)
	I n 13	II n 2	III n 11	IV n 8	
0	2	2	2	0	4.6 (1.4)
1	10	0	5	2	3.5 (2.4)
2	1	0	4	6	3.9 (2.6)
Capsular distension	3.8 (2.3)	4.9	4.5 (2.8)	2.7 (1.8)	

[a] 0 no displacement, 1 no interruption of cortical contact, but slight compression medially, laterally, or dorsally, 2 fracture displacement and cortical interruption.
[b] Garden stage.

The results of postoperative hip joint aspiration in 11 patients are listed in Table 3. The intracapsular pressure was increased in all 11 hips, with a mean of 58–112 mmHg. In most patients, there was a correlation between the aspirated volume and the intracapsular pressure ($r^2 = 0.39$). Cases 31 and 32, with moderate capsular distension, had high intracapsular pressures, although only 1.0 and 0.5 ml, respectively, was aspirated. The aspiration was repeated in these 2 patients without

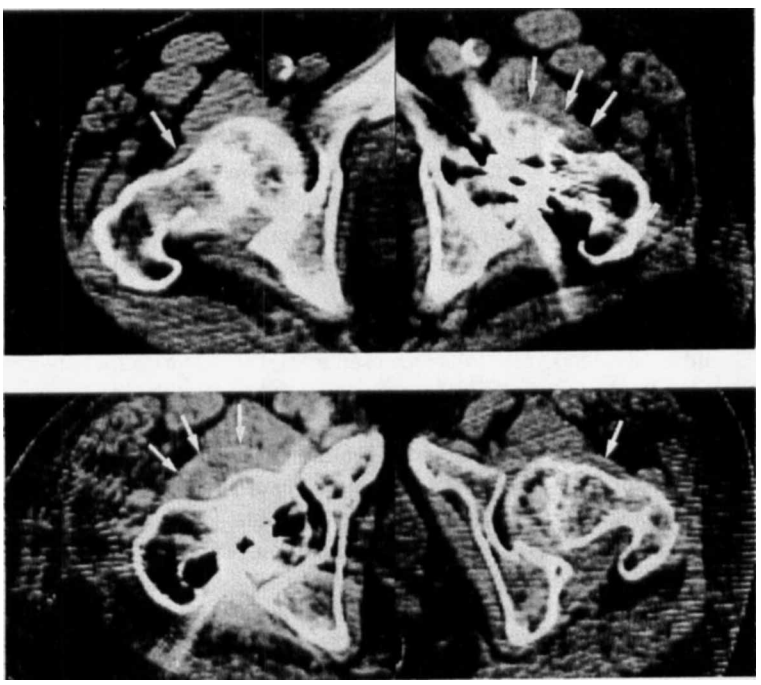

Figure 1. CT of the hips of a 79-year-old female with a left cervical hip fracture (Case 15 in Table 3). On the right normal side, the capsule (arrow) follows the neck equidistantly at 4.5 mm. The distance between the neck and the ventral aspect of the capsule on the left side is (arrows) 10 mm, indicating an effusion or capsular "thickening" of 5.6 mm. It is not possible to evaluate the posterior aspect of the capsule due to the transmission artefacts produced by the two metal pins.

Figure 2. An 81-year-old female with a right cervical hip fracture, Garden III. CT was performed 3 days after fixation with two pins. As compared with the normal hip, there is a large distension of the capsule (arrows). Although beam-hardening artefacts are present, it is possibe to distinguish between the capsule and the effusion, having a lower CT density.

Table 2. Correlation between the degree of capsular distension (mm) and scintimetric femoral head ratio in 30 patients with cervical hip fractures

Ratio	Capsular distension		
	< 3	3–4	> 4
< 0.9	3	2	3
0.9–1.1	1	1	1
> 1.1	4	4	11

Table 3. Capsular distension, intracapsular pressure and femoral head vitality following fixation of femoral neck fracture

A	B	C	D	E	F	G	H	I
15	79	F	IV/2	6	5.6	3.0	65	0.67
21	92	F	III/0	1	6.5	0.5	30	1.8
25	63	F	III/2	32	3.6	23	102	0.50
26	74	F	III/1	4	9.5	0.1	27	1.75
28	83	F	II/0	3	5.9	11	112	1.70
29	79	F	I/1	2	1.1	3.0	65	1.2
30	71	F	III/1	3	7.1	0.25	10	1.45
31	75	F	I/1	3	6.5	1.0	108	1.25
32	75	F	IV/2	2	2.8	0.5	80	1.80
33	89	M	I/1	4	5.1	0.0	25	1.25
34	85	F	III/2	3	7.8	0.0	10	1.17

A patient number, B age, C sex, D preoperative/postoperative classification of fracture displacement, E interval in days between operation and CT/joint aspiration, F capsular distension measured by CT, G volume of aspirated intracapsular fluid, H intracapsular pressure (mmHg) with the hip in neutral position, I scintimetry of the femoral head ratio – injured/intact side about 2 weeks postoperatively.

further result. Cases 15, 25, and 28 had immediate relief of pain at aspiration, and their hip motion increased momentarily.

Discussion

CT has proved valuable in diagnosing hip joint effusion (Egund et al. 1986, Wingstrand et al. 1986). The examination causes little discomfort to the patient and is performed in 5 minutes if target scans are not used. In the measurement of the neck-capsule distance in transient synovitis of the hip, the correct window setting has been determined (Koehler et al. 1979, Egund et al. 1986), as well as the potential of CT in visualizing both the intraarticular effusion and the ileofemoral ligament (Egund et al. 1986). In the present study the assessment of hemarthrosis by CT was influenced by the different composition of the intraarticular effusion. Fresh hematomas have a CT attenuation similar to that of the capsule (Merino de Villasante and Taveras 1976), and the metal pins produced transmission artefacts. In 25 cases, our CT technique did not differentiate between effusion and edema of synovial structures.

All but 1 of our cases had distension of the joint capsule. This was less pronounced in the displaced Garden IV fractures, which supports the view that capsular rupture is common in these fractures (Soto-Hall et al. 1963, Nagy et al. 1975, Drake and Meyers 1984), and that the hip joint may be drained through these ruptures. Capsular distension, however, was present in all the Garden IV fractures, and large capsular distensions were recorded in some patients who had little or no intraarticular fluid at needle aspiration. This suggests that intraarticular synovial edema in addition to hemarthrosis is responsible for the distensions recorded by CT.

The intracapsular pressure was raised in all 11 hips in which this examination was performed. However, there was no correlation of intracapsular pressure to capsular distension. This accords with findings in children with transient synovitis of the hip (Wingstrand 1986, Wingstrand et al. 1985a, b). In 4 patients with intraarticular pressure between 25 and 108 mmHg, almost no fluid was aspirated. Similar results have been obtained in patients with synovitis of the hip due to juvenile chronic arthritis (Rydholm et al. 1986).

The relief of pain and restoration of active and passive motion after reduction of intracapsular pressure by aspiration of the hip joint, noticed in 3 patients, suggest a clinical condition that should be considered when mobilization and pain postoperatively are more troublesome than usual.

If performed 1–3 weeks after femoral neck fracture fixation, scintimetry with ^{99m}Tc-MDP is a reliable predictor of the course of healing (Strömqvist et al. 1983, 1984, 1987). In several cases the 1–3-week postoperative scan has shown a decrease in femoral head vitality when compared with a preoperative scan (Strömqvist and Hansson 1983, Strömqvist et al. 1984). This has been ascribed to a traumatizing effect of the nailing procedure, but in view of the present results increased intracapsular pressure may also contribute to decreased femoral head vitality.

The hip joint capsule contains the main vascular supply to the femoral head when the intraosseous pathway has been interrupted by a fracture through the neck (Trueta and Harrison 1953, Crock 1980). Synovitis and increased intracapsular pressure therefore may compromise femoral head vitality as recently demonstrated in patients with undisplaced fractures of the hip (Wingstrand et al. 1986). In comparison the intracapsular

pressures recorded in our postoperative patients were moderate and all below systolic blood pressure. However, also a lower pressure may disturb the venous flow of the intracapsular vessels. This may explain why patients with rheumatoid synovitis sustaining femoral neck fractures have an increased incidence of femoral head necrosis (Strömqvist 1984).

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