Postoperative Tc-scintimetry in femoral neck fracture

A prospective study of 46 cases

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13 men and 33 women with 8 undisplaced and 38 displaced fractures of the femoral neck treated with internal fixation were included in a prospective study of Tc-scintimetry performed early (1–3 weeks), as well as after 2 and 12 months. 9 fractures redisplaced and 5 had late segmental collapse.

Healing complications were associated with decreased uptake in early and 2-month scintimetry, but the specificity was only 50 percent. With normal or increased uptake, uncomplicated healing of the fracture was predictable with 90–100 percent sensitivity.

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We have studied the prognostic accuracy of postoperative bone scintimetry in a prospective series of femoral neck fractures, to identify subgroups at high risk for healing complications, to reduce delay in treatment or, at low risk, to obviate unnecessary follow-up.

Patients and methods

During a period of 15 months (October 1989–January 1991) 186 patients were admitted with acute fracture of the femoral neck. Following internal fixation, the patients were given oral and written information, and offered scintimetry 1–3 weeks postoperatively, after 2 months and 1 year. The study was approved by the local Ethics Committee. Excluded from the study were patients from nursery homes, and those with contralateral hip disease (Table 1).

46 patients with a median age of 74 (52–95) years and female/ male ratio of 2.5 were included. 9 patients died during follow-up (Table 2).

Fixation was performed with a dynamic hip screw (AO-DHS) as soon as possible following admission. The procedure was performed by the surgeon on call on a traction table with fluoroscopic guidance.

Radiographs (AP and axial projections) were done postoperatively, after 2 months, 1 and 2 years. The fractures were classified as undisplaced (Garden Types 1 and 2) or displaced (Types 3 and 4). Reduction was defined as acceptable if the Garden alignment index was 155–185 degrees in both views, and the ad latus displacement did not exceed one-fourth of the diameter of the femoral neck (Alberts and Jervaeus 1990).

Sliding of the screw into the barrel was calculated (Doppelt 1980). Redisplacement was defined as loss of reduction, early within 3 months or late within 3–6 months. Segmental collapse was defined as deformity of the weight-bearing part of the femoral head after fracture healing.

Planar bone scintimetry was performed 2–3 hours following an intravenous injection of 500–700 MBq ^{99m}Tc-DPD (technetium dicarboxy-propane diphosphonate), using a Siemens gamma camera ZLC with a low-energy ultra-high resolution collimator. An anterior view of 500,000 counts was obtained over the pelvis and hips, with the patient in supine position after bladder emptying. The records were stored on floppy discs, regions of interest were selected centrally in both femoral heads, and an uptake fractured/intact side ratio was calculated (Figure 1). The ratio levels of 1.0 for early scintimetry and 1.25 for scintimetry at 2

Table 1. Patients excluded

Reason	n	Percent
Nursery home resident	47	34
Age < 50 years	3	2
Contralateral disease	3	2
Pathological fracture	3	2
Primary hemiarthroplasty	26	19
Refused to participate	41	29
Miscellaneous	17	12
Total	140	100

Table 2. General table

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	72	1	2	1	72	1	1	7	2	8	2	2	0.96	1.37	1.02	3	2	2	
2	76	1	4	1	28	1	1	14	2	22	2	2	0.86	1.01	0.89	2	2	3	d
3	75	2	3	1	6	1	1	8	2	17	2	1	0.83	0.97	0.9	3	3	3	
4	79	2	3	1	20	1	1	8	2	13	2	2	1.28	1.22	0.99	2	1	2	
5	72	1	2	2	31	1	1	7	2	8	2	2	1.06	1.37	1.07	2	1	2	
6	95	1	3	1	30	1	1	6	2	11	2	2	0.9	1.81	1.17	3	1	1	d
7	66	1	3	1	22	1	2	15	2		1		0.82	1		3	3		
8	83	2	3	1	15	1	2		1		2	1	0.89	1.67		3	1	2	
9	58	1	3	1	18	1	2	6	2	11	2	1	1.23	1.17	1.2	3	3	3	
10	72	1	3	1	36	1	2	10	2				1.08	2.01		2	1		d
11	71	2	3	1	7	1	1	5	2	5	2	2	0.37	0.9	1.03	3	2	2	
12	82	1	3	1	9	1	1	6	2	10	2	2	0.72	1.5	1.46	2	2	1	
13	84	2	4	1	6	1	1	9	2				1.67	3.31		2	1		d
14	73	2	2	2	44	1	1	8	2	9	2	2	1.69	1.42	1.94	1	1	1	d
15	59	2	3	1	10	1	1	6	2	6	2	2	1.41		0.95	1		2	
16	87	2	3	1	12	1	2	13	1				0.94			3			
17	64	1	4	1	17	1	2	14	2				1.17	2.05		2	1		d
18	58	2	2	1	10	1	1	14	2	14	2	2	0.94	1.29	1.77	3	2	1	
19	71	2	4	1	28	1	1	7	2	10	2	2	1.46	2.61	1.25	1	1	1	
20	65	2	3	2	99	1	2	8	1				0.95	0.93		3	3		
21	67	1	3	2	24	1	2	14	2	28	2	2	1.08	1.54	2.06	3	3	2	i
22	70	2	4	1	13	1	2	12	2		1		0.74	0.95		3	3		
23	80	1	3	1	20	1	2	15	2	10	2	2	1.24	1.58	1.62	2	1	1	d
24	67	2	4	1	5	2	2	5	2	6	2	2	0.82	1.54	1.5	2	1	1	
25	78	2	4	1	17	1	1	7	2	8	2	2	3.7	2.98	2.06	1	1	1	
26	74	2	3	1	10	2	1	5	2	7	2	1	0.53	0.77	0.65	3	3	3	
27	80	2	3	1	32	1	2	7	2				0.6	1.14	2.14	3	2	1	
28	80	2	2	1	18	1	2	2	2	2	2	2	0.8	2.27	2.1	3	1	1	
29	76	2	4	1	12	1	2	17	1				0.79			3			
30	90	2	3	1	9	1	1	11	2	12	2	2	0.68	1.69	1.09	3	1	2	
31	73	2	3	2	6	2			1				0.87			3			
32	59	2	3	1	12	1				14	2	1	0.86	1.44	0.88	3	2	1	
33	88	2	2	2	30	1	1	9	2	9	2	2	2.22	1.63	0.81	1	2	2	
34	64	2	4	1	15	1	1	11	2	12	2	2	2.91	4.99	1.73	1	1	1	
35	68	1	4	1	43	1	2	17	2	18	2	2	1.03	3.25	1.46	2	1	2	
36	70	2	1	2	12	1	2	4	2	4	2	2	1.14	1.23	1.05	1	1	2	
37	52	2	3	1	12	1	2	4	2	4	2	2	0.96	1.75	1.75	2	2		
38	78	2	3	1	9	1	2	18	2		1		0.77	1.24		3	3	3	
39	73	2	4	1	12	2	2	11	1				0.8			3			
40	76	2	3	1	8	1	2	13	2				0.91	1.05		3	3		i, d
41	79	1	2	1	27	1	1	6	2				1.75	1.22		1	1		d
42	76	2	4	1	21	1	2	5	2	9	2	2	0.86	1.96	1.29	3	2	1	
43	87	2	4	1	10	2	2	10	2	10	2	2	0.87	3.27	1.14	3	1	2	
44	76	2	4	1	41	1	1	13	2	12	2	2	2.36		1.24	1		1	
45	74	2	4	1	8	1	2	14	2	16	2	2	1.25	2.92	0.9	2	2	2	
46	72	2	4	1	8	1	1	12	2	18	2	1	1.45	1	0.99	3	3	3	

A Case number
B Age (years)
C Sex
  1 male
  2 female
D Garden Types (1–4)
E Traction
  1 yes
  2 no
F Admission to surgery (hours)
G Reduction
  1 good
  2 poor
H Union at 2 months
  1 yes
  2 no
I Sliding of screw at 2 months (mm)
J Redisplacement at 2 months
  1 yes
  2 no
K Sliding of screw at 1 year (mm)
L Late redisplacement
  1 yes
  2 no
M Segmental collapse
  1 yes
  2 no
N Postoperative uptake ratio
O Uptake ratio at 2 months
P Uptake ratio at 1 year
Q Visual assessment of postop. scintimetry (↑/→/↓ 1/2/3)
R Visual assessment of scintimetry at 2 months (↑/→/↓ 1/2/3)
S Visual assessment of scintimetry at 1 year (↑/→/↓ 1/2/3)
T Remarks
  d died
  i deep infection

months were selected according to Strömqvist (1983), but were also the most accurate in the present material (Figure 2).

In addition, a visual assessment (normal, increased or decreased uptake in the affected femoral head) was performed by a specialist in nuclear medicine, who did not know the clinical course. *Sensitivity* was calculated as the number of true negatives divided by all cases with normal or increased uptake; and *specificity* as the number of true positives divided by all cases

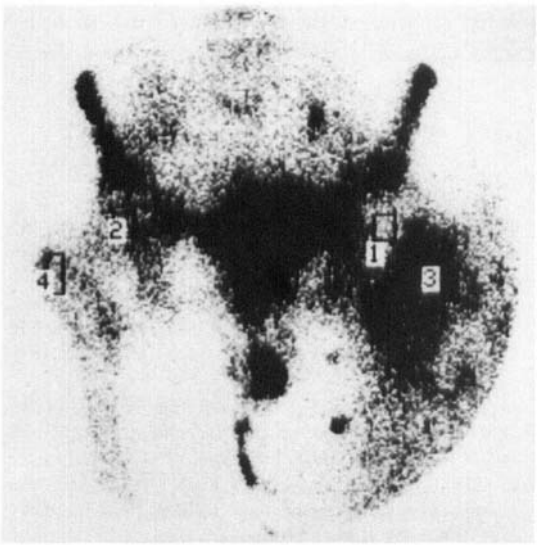

Figure 1. Case 7. Scintigraphy with regions of interest in both femoral heads (1 and 2). Reduced postoperative uptake (ratio 0.82).

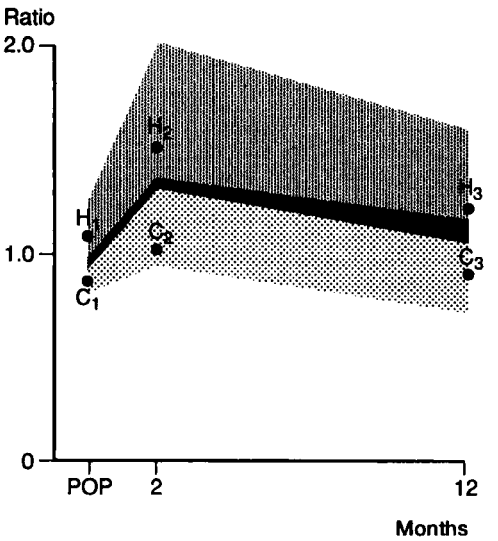

Figure 2. Uptake fractured/intact side ratio of healed fractures (H) and fractures with complications (C). Median differences in the early postoperative period (POP) 0.20 (0.04–0.43), at 2 months 0.57 (0.25–1.04), and at 12 months 0.38 (0.07–0.86).

with reduced uptake. Prognostic accuracy was determined as the total number of correct diagnoses divided by the total number of cases.

Statistical analysis was performed with the Mann-Whitney *U*-test and the chi-square test. 95 percent confidence limits of data were calculated.

Results

During the study period (minimum 2 years or until a complication occurred), 14 hips developed healing complications with 6 early and 3 late redisplacements, and 5 segmental collapses. 12 cases were reoperated on because of healing complications, and Case 21 with diabetes mellitus and Case 40 with intra-abdominal abscesses, were reoperated on because of a deep infection, but both had no signs of healing complications. Case 8 with early minor redisplacement, and later signs of segmental collapse and a contralateral femoral neck fracture, and Case 9 with segmental collapse did not undergo further surgery.

5 cases died 5–12 months after surgery, all had passed the first two scintimetric examinations, and 4 cases died within the next year, and none of them had healing complications.

No differences were found between patients with or without complications concerning delay of operation, quality of reduction, or sliding of screw.

Uptake ratios were different at early scintimetry (P 0.01), at 2 months (P 0.0004), and at 12 months (P 0.01) (Figure 2). Patients without complications had increased uptake after 2 months, whereas patients with complications showed only a minor increase. By 12 months, both groups were approaching a normal ratio.

The specificity of an early postoperative uptake ratio < 1.0 was 0.46, and the sensitivity was 0.90 (Table 3). Cases 9 and 46 with a normal initial ratio developed segmental collapse (false negative). At 2 months, the specificity of a ratio < 1.25 was 0.53, and the sensitivity 0.92. The prognostic accuracy was 0.65 (early) and 0.78 (2 months).

The visual assessment achieved slightly better results (Table 3) with sensitivities of 1.00–0.93 and specificities of 0.52–0.80. The prognostic accuracies were 0.76 and 0.90.

Table 3. Uptake ratios and visual assessment postoperatively (and at 2 months)

	Complication n 14 (10)	No complication n 32 (30)
Ratio < 1.0 (1.25)	12 (8)	14 (7)
Ratio ≥ 1.0 (1.25)	2 (2)	18 (23)
Decreased	14 (8)	11 (2)
Normal/increased	0 (2)	21 (28)

Early ratio X^2 5.376; P 0.02.
2-month ratio: X^2 8.000; P 0.005.
Early assessment: X^2 14.363; $P < 0.00005$.
2-month assessment: X^2 17.778; $P < 0.00005$.

Discussion

Preoperative scintimetry in femoral neck fracture is cumbersome and does not predict the outcome sufficiently well (Alberts 1990, Lausten et al. 1992). Postoperative scintimetry has been shown to possess a high prognostic value (Strömqvist 1983, Strömqvist et al. 1987). Our prognostic accuracies of 60–75 percent in early scintimetry and 80–90 percent after 2 months confirm the recent prospective study by Alberts (1990). However, calculation of uptake ratios is time-consuming; in our study the results were not better than visual assessment.

Risk of healing complications was found following decreased uptake in early scintimetry, but with a low specificity. Following a normal or increased uptake, uncomplicated healing of the fracture was predictable, due to a high sensitivity.

For patients with displaced femoral neck fractures and a fair expectation of life, postoperative Tc-scintigraphy is recommended. In case of normal or increased uptake, no further follow-up is warranted, if no other complications are found (poor reduction, malposition of screw, infection, etc.). In decreased postoperative uptake, scintimetry should be repeated at 2–3 months, and if the uptake is continuously low, and the hip is painful, reoperation should be considered. In undisplaced fractures, scintimetry can be omitted due to their benign course.

References

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