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A RADIOGRAPHIC FIVE-YEAR FOLLOW-UP OF FEMORAL NECK FRACTURES

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Forty femoral neck fractures were followed for 5 years in a prospective clinical, roentgenographic and scintimetric investigation. Thirteen cases had uncomplicated healing, 22 necrosis and five non-union. The diagnostic value of radiographic changes was analysed with reference to development of necrosis of the femoral head or non-union. Sclerosis of the femoral head, and compression and displacement of the fracture were compatible with eventual healing and clinical recovery. Subchondral fracture and collapse of the load-bearing surface, diagnostic for necrosis, were observed in only 7 of 22 cases at 1 year and as late as 3–5 years in three cases. By contrast, four out of five non-union cases were established radiographically within 1 year. Patients needing an arthroplasty after fracture of the femoral neck should be identified on clinical grounds after early radionuclide scintimetry. Waiting for radiographic documentation of necrosis in cases with pain will increase the risk for physical and social impairment associated with poor function of the hip.

Key words: femoral neck fracture; non-union; osteonecrosis; radiography; scintimetry

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There is no long-term investigation in the recent literature of the diagnostic value of radiographic changes in the femoral head and neck after intracapsular hip fracture. Radiographic changes followed for up to 5 years in cases destined to uncomplicated healing, necrosis or non-union/pseudarthrosis were compared with findings of ^{85}Sr-scintimetry at 4 months in order to define the indications for radiographs and to examine more closely the value of radiographic examinations in the management of hip fracture.

MATERIAL AND METHODS

The material in this prospective investigation comprised 40 patients with intracapsular subcapital or transcervical femoral fractures admitted to the Department of Orthopaedic Surgery, University Hospital in Lund during the period May 1975–May 1976. Patients unable to cooperate or who did not have a radiographically normal contralateral hip were not selected for the investigation.

The mean age of the patients was 73 (38–93) years; all but six patients were older than 60 years (Table 1). The patients were followed up at 4 and 6 months and at 1 and 2 years, and they were interviewed at 5 years. Eight of the 40 patients died within 5 years.

The fractures were operated as soon as the patient's general condition and the resources of the surgical unit permitted, i.e. usually within 24–48 h. Before the operation unstable fractures were treated with traction through the tibial tuberosity. The operation was performed under image intensifier control, and the Rydell (1964) four-flanged nail was used. The patients were encouraged to walk with full weight-bearing the day after the operation (Ceder et al. 1980).

The patients were followed-up clinically at 4 and 6 months, at 1 and 2 years, and they were interviewed 5 years after the fracture.

Radiographic data (Table 1)

On admission, the hips were radiographed in anteroposterior and lateral projections and the fractures were classified according to Garden's (1961) system, modified according to Graham & Wood (1976). A distinction was made between fractures with *minor displacement* (Garden I and II, 9 cases) and those with *major displacement* (Garden III and IV, 31 cases). The fractures were classified as *healing without complications* (13 cases) when there was no appearance of collapse of the femoral head and the fracture was not visible, as *non-union* (five cases) when the fracture was visible with sclerotic bone on one or both sides, or *necrosis* (22 cases). Necrosis was diagnosed when compression of the loadbearing surface and subchondral fracture was observed. The diagnosis was confirmed histologically in those patients who had a secondary arthroplasty. In certain cases the patients were followed radiographically for 3, 4 and even 5 years if necrosis had not been visible in earlier examinations.

RESULTS

The fate of the fractures was correlated to the preoperative displacement and the postoperative position (Table 2).

Uncomplicated healing (Table 3)

Compression in the fracture area was present in 3 of 13 uncomplicated healing cases at 4 months. In two cases of those with major displacement, compression had increased at 6 months but further changes did not occur. *Displacement* without further changes was noted in one case at 4 months.

Sclerosis in the femoral head was present at 4 months in 3/13 cases and in one more case at 6 months. Increased changes at 6 months and 1 year occurred in 3/12 and 4/12 cases. In no case

Table 1. Classification and end results of femoral neck fractures

Fracture type	Uncomplicated healing	Necrosis	Non-union	Total	Mean age (range)
Minor displacement	6	3	0	9	73 (52–87)
Major displacement	7	19	5	31	73 (38–93)
Total	13	22	5	40	73 (38–93)

Table 2. Postoperative position and end results of femoral neck fractures

Fracture displacement		Uncomplicated healing	Necrosis	Non-union	Total
Preoperative	Postoperative				
Minor	Satisfactory	4	3	–	7
	Varus	–	–	–	–
	Valgus	2	–	–	2
		6	3	–	9
Major	Satisfactory	4	12	3	19
	Varus	1	1	–	2
	Valgus	2	6	2	10
		7	19	5	31

Table 3. Radiographic observations in femoral neck fractures with uncomplicated healing

Changes in	4 months				6 months				1 year				2 years			
	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
Femoral neck																
Compression	3	–	–	10	–	2	1	9	–	–	3	9	–	–	2	7
Displacement	1	–	–	12	–	–	1	11	–	–	1	11	–	–	1	8
Femoral head																
Sclerosis	3	–	–	10	1	3	–	8	–	4	–	8	–	1	1	7
Dead										1				3		
Refused investigation							1							1		

a = new changes; b = increased changes; c = no change from preceding investigation; d = no changes.

Table 4. Radiographic changes in femoral neck fractures with necrosis

Changes in	4 months				6 months				1 year				2 years			
	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
Femoral neck																
Compression	13	–	–	9	–	7	6	8	1	3	8	8	1	3	8	6
Displacement	3	–	–	19	–	1	2	18	–	–	3	17	1	–	3	14
Fracture gap	2	–	–	20	1	–	2	18	1	–	3	16	–	–	–	18
Femoral head																
Sclerosis	4	–	–	18	7	4	–	10	4	8	1	7	4	11	1	2
Subchondral fracture	–	–	–	22	–	–	–	21	2	–	–	18	5	1	1	11
Segmental collapse	1	–	–	21	1	–	1	19	4	1	1	14	4	3	3	8
Refused investigation			–				1				–				1	
Hip arthroplasty			–				–				2				3	
Total			22				22				22				22	

a = new changes; b = increased changes; c = no change from preceding investigation; d = no changes.

did sclerosis disappear within the time of observation.

Necrosis (Table 4)

Compared with postoperative radiographs, no changes at all were observed in 7/22 necrosis cases at 4 months, in 6/21 at 6 months, in 5/20 at 1 year and in only one of 18 cases examined 2 years after fracture.

In contrast to uncomplicated healing cases, *compression* in the femoral neck was more frequent in necrosis cases. About two thirds of the necrosis cases showed compression at 4 months; this compression had increased at 6 months in one third of these cases.

Displacement of the femoral head was found in three cases at 4 months; in one of them the displacement increased, but none of these cases had hip replacement. One case had displacement 2 years after the fracture and had hip replacement at 3 years.

The fracture gap had disappeared by 2 years in all the necrosis cases.

Table 5. Radiographic changes in femoral neck fractures with major displacement and non-union

Changes in	4 months				6 months				1 year				2 years			
	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
Femoral neck																
Compression	4	–	–	1	1	3	–	–	–	1	1	–	–	2	–	–
Displacement	2	–	–	3	–	1	–	3	–	–	–	2	1	–	–	1
Fracture gap	1	–	–	4	–	1	–	3	–	–	–	2	2	–	–	–
Femoral head																
Sclerosis	2	–	–	3	1	2	–	1	–	1	1	–	–	2	–	–
Hip arthroplasty			–				1				3				3	
Total			5				5				5				5	

a = new changes; b = increased changes; c = no change from preceding investigation; d = no changes.

Sclerosis was seen later than in uncomplicated healing cases, and it increased during the follow-up.

Subchondral fracture was not observed before the 1-year examination; at 2 years a subchondral fracture was present in 7 of 18 cases of necrosis.

Segmental collapse was diagnosed in one case at 4 months. This was an 85-year-old woman with Parkinson's disease and dementia who had been operated on twice because of inadequate primary reduction and fixation. After the second operation the nail penetrated the femoral head. Except for this case segmental collapse was present at 6 months in one of three cases with minor displacement and in none of the 19 cases with major displacement. One year after fracture segmental collapse was found in four cases, and after 2 years in another four cases, all with initial major displacement.

Non-union (Table 5)

Non-union developed only in fractures with major displacement. Radiographic changes were mostly observed in the femoral neck, such as compression in all five cases, displacement in three of five cases and a fracture gap in three of five cases. In the femoral head, sclerosis was present in both non-reoperated cases at the 1- and 2-year examinations.

DISCUSSION

In the management of femoral neck fractures, radiographic examinations are indispensable for the diagnosis, and for guidance and control of the nailing procedure. In the further postoperative course their value is rather limited. This investigation has demonstrated that early compression and even displacement of the fracture and sclerosis of the femoral head may occur without future non-union or late segmental collapse (Figures 1 and 2).

Furthermore, even if sequential radiographic examinations were predictive of complications, their value is limited by the lack of technology for changing the natural course of the failing femoral neck fracture. The procedure in such cases, a hemi- or total arthroplasty, is undertaken not on the basis of radiographs but because of impaired function of the hip, i.e. on clinical grounds; in this material only one third of the patients with segmental collapse and/or subchondral fracture had an arthroplasty within 5 years of the fracture (Brümmer 1983).

It would thus seem that routine radiographic examinations of intracapsular hip fractures could be dispensed with after the immediate postoperative period.

However, definite radiographic evidence of femoral head collapse is often not available until 2 years or more after the fracture. In some of these cases an early secondary arthroplasty would

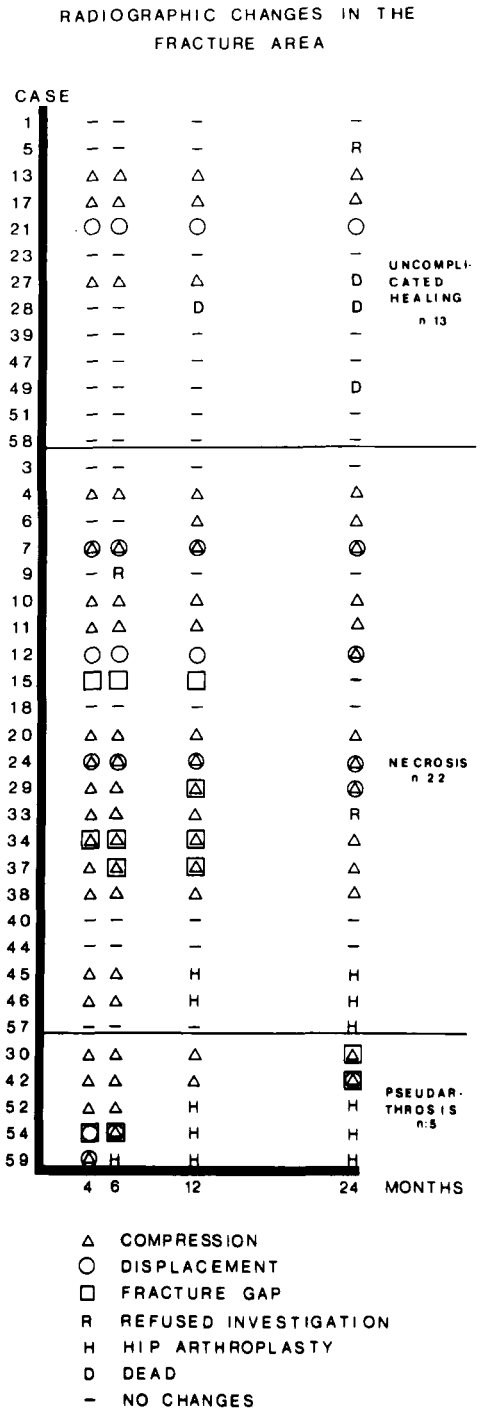

Figure 1. Radiographic changes in femoral neck fractures (40).

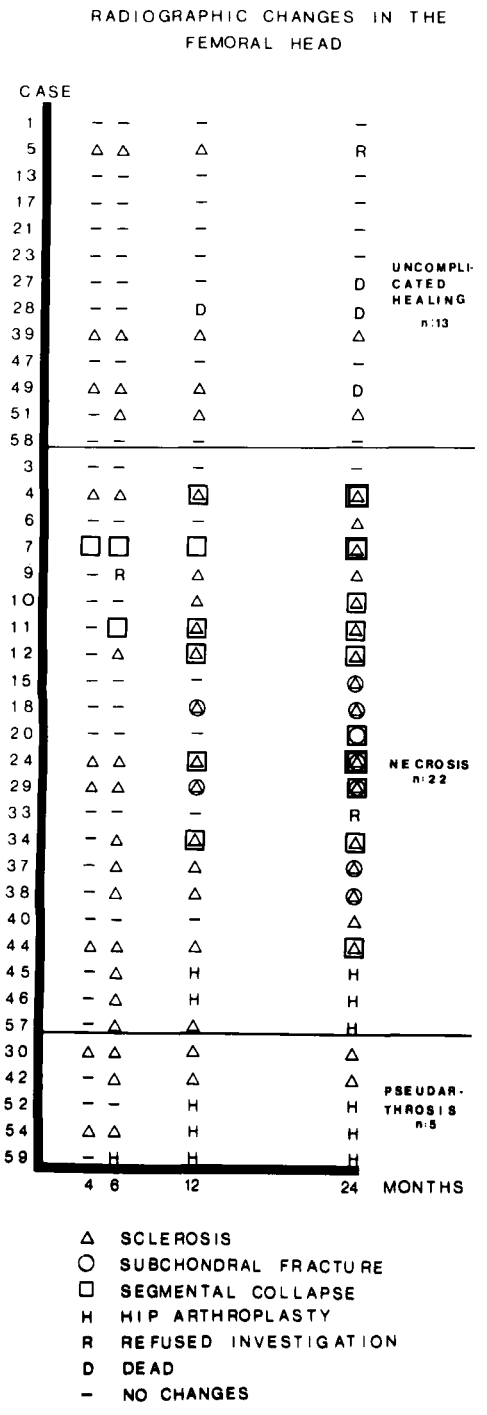

Figure 2. Radiographic changes in femoral neck fractures ($n = 40$).

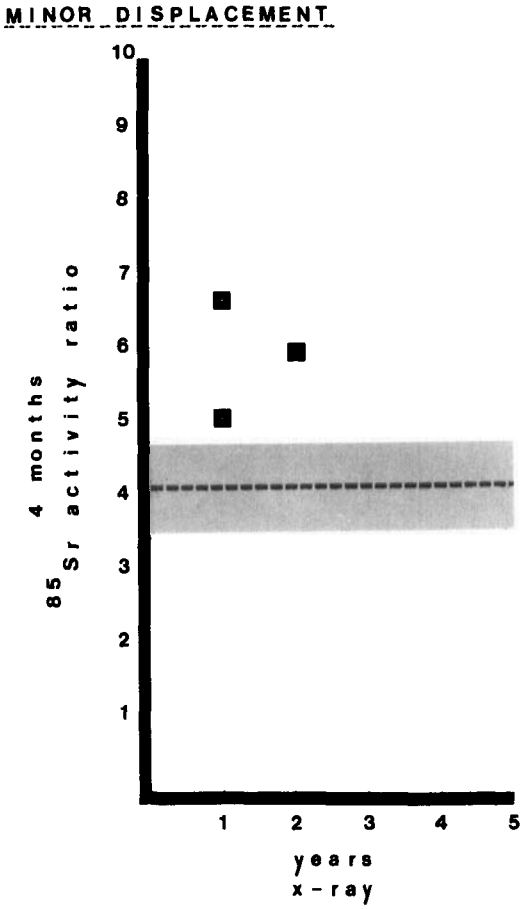

Figure 3. ^{85}Sr activity ratio in the c_4-sector (base of femoral head and subcapital area of the femoral neck) at 4 months. Cases with minor displacement and necrosis in relation to the time of radiographic diagnosis. Grey zone = activity ratio in uncomplicated healing cases. ■ = activity ratio in necrosis.

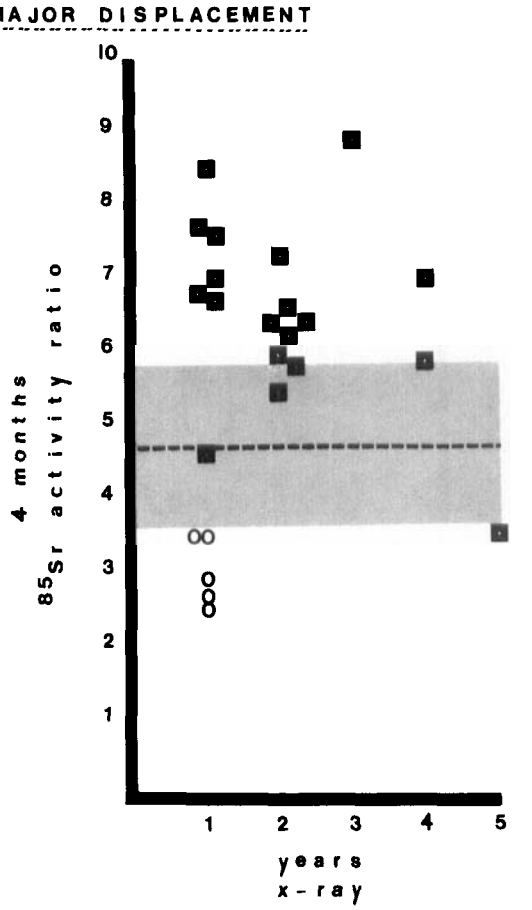

Figure 4. ^{85}Sr activity ratio in the c_4-sector (base of femoral head and subcapital area of the femoral neck) at 4 months. Cases with major displacement and necrosis, respectively pseudarthrosis/non-union, in relation to the time of radiographic diagnosis. Grey zone = activity ratio in uncomplicated healing cases. ■ = activity ratio in necrosis. ○ = activity ratio in pseudarthrosis/non-union.

prevent physical and social deterioration. Pain does not suffice as an indication for a secondary operation; in this material one third of those whose fractures healed without structural complications had pain on weight-bearing at 6 months (Brümmer 1983). The radiographic classification based on initial displacement is likewise imprecise in the prediction of complications; three of the nine Garden I and II fractures had structural complications.

In these cases radionuclide techniques should replace radiographic examinations in the decision process whether or not to consider a secondary procedure. In this material (Brümmer et al. 1982), ^{85}Sr scintimetry at 4 months was predictive of non-union (low values) or late collapse (high values) (Figures 3 and 4). However, this method has little predictive value when applied to fresh fractures.

Strömqvist (1983) has now summarized the experience in this department of the use of ^{93}Technetium labelled methylene diphosphonate for evaluation of the vitality of the femoral head in fresh intracapsular hip fractures (D'Ambrosia

et al. 1975, Bauer et al. 1980). It appears that this technique permits a near perfect distinction between femoral neck fractures destined to uncomplicated healing and those destined to non-union or collapse of the femoral head.

The place of radiographic examinations in fracture of the femoral neck should thus be limited to *preoperative* diagnosis and classification, *peroperative* guidance, and to early *postoperative* control after weight-bearing to check the mechanical solidity of the fracture. Routine radiographic examinations of the subsequent course are superfluous – and expensive – because they have little predictive value and hardly any effect on management of the fractures.

REFERENCES

D'Ambrosia, R. D., Shoji, H., Riggins, R. S., Stadalnik, R. C. & De Nardo, G. L. (1978) Scintigraphy in the diagnosis of osteonecrosis. *Clin. Orthop. Rel. Res.* **130**, 139–143.

Bauer, G., Ceder, L., Darte, L., Egund, N., Hansson, L. I., Strömqvist, B. & Weber, D. (1980) Dynamics of technetium-99m methylenediphosphonate imaging of the femoral head after hip fracture. *Clin. Orthop. Rel. Res.* **152**, 85–92.

Brümmer, R., Hansson, L. I., Mortensson, W. & Sjöstrand, L. O. (1982) ^{85}Sr – scintimetry in femoral neck fracture. *Arch. Orthop. Traum. Surg.* **101**, 47–51.

Brümmer, R. (1983) Natural course in nailed fractures of the femoral neck. A 5-year prospective investigation. In preparation.

Ceder, L., Lindberg, L. & Odberg, E. (1980) Differentiated care of hip fracture in the elderly. *Acta Orthop. Scand.* **51**, 157–162.

Garden, R. S. (1961) Low angle fixation in fractures of the femoral neck. *J. Bone Joint Surg.* **43**-B, 647.

Graham, J. & Wood, S. K. (1976) *Aseptic necrosis of bone following trauma,* pp. 101–142. Excerpta Medica, Amsterdam.

Rydell, N. (1964) Osteosynthesis of medial collum fractures with the "spring-loaded nail". *Acta Orthop. Scand.* **35**, 149.

Strömqvist, B. (1983) Femoral head vitality after intracapsular hip fracture. 416 cases studied by intravital tetracycline labeling and Tc-MDP radionuclide scintimetry. Thesis, Lund.

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