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EARLY WEIGHTBEARING AFTER CLASSICAL INTERNAL FIXATION OF MEDIAL FRACTURES OF THE FEMORAL NECK

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The treatment of medial fractures of the femoral neck is still a difficult undertaking, and the various factors involved are as yet imperfectly understood. Bone union does not always take place and late complications are common (Barnes 1970). The wide use of treatment with a primary prosthetic replacement has not solved the problem (Gossling & Hardy 1969, Lunt 1971, Evarts 1973, Hunter 1974). Although it has been possible by means of internal fixation methods, based on low-angle nailing, to improve the weightbearing stability of the nailed fracture (Spotoft 1944, Küntscher 1954, Backman 1957, Garden 1961, Bonnin & Cashman 1963) failures are common even in patients treated in this way (Ainsworth 1971, Massie 1973).

A long period without weightbearing, even up to 6 months, has generally formed a part of the treatment based on the classical nailing method. (The nail runs along the central axis of the femoral neck in the manner of, for example, Smith-Petersen or Johansson) (DePalma 1970, Campbell 1971). This has been considered necessary not only because of the instability of the fracture, but also because early compression is thought to increase the possibility of necrosis of the femoral head (Rokkanen & Slätis 1967). However, as long ago as 1937 Moore observed that early weightbearing after nailing did not increase the likelihood of late complications. There have been a number of comparative studies since then in which, as a sequel to the classical nailing method, some of the patients were allowed to use the limb for weightbearing rather soon (approximately 2 weeks) after the nailing of the fracture (Gibson 1964, Brown & Abrami 1964, Häggqvist 1969). However, the follow-up period in these studies has never been longer than 1 year. In a similar study by Graham (1968) the follow-up period

was 3 years. After this 3-year period, no difference was observed, as far as failure of fixation or pseudoarthrosis were concerned, between patients who started weightbearing early or late (late being 12 weeks after the nailing). Necroses of the femoral head were even more common among late weightbearing patients. The difficulty of finding truly comparable groups for this kind of study has been stressed by Graham. There are studies by Garden (1961), Bonnin & Cashman (1963), Smyth et al. (1964), Hullinger (1967) and Ainsworth (1971) in which the authors show that among patients treated with low-angle nailing and who were also early weight-bearers there was no increase in necroses of the femoral head.

The department of internal medicine in the Municipal Hospital in Turku has developed special facilities for the treatment of long-term patients and elderly people. Because long periods in bed are especially trying for elderly patients and easily lead to mental and physical collapse, patients with hip fractures in this hospital are got onto their feet as soon as possible. This policy has been followed in the hospital since 1960. In the case of medial fracture of the femoral neck patients are allowed to bear their own total weight, by degrees, within 3 weeks of operation (Ruikka 1972). The following study was made possible by the putting into practice of this policy and the object was to determine the effect of early weightbearing on the late results of treatment for medial fracture of the femoral neck after the classical nailing method.

MATERIAL AND METHODS

The study includes all adult patients treated over an 8-year period between 1964 and 1971, primarily for medial fracture of the femoral neck, in the surgical clinics of the University Hospital in Turku and the Municipal Hospital in the same city. In all 436 patients are considered and during the period under review there were 446 medial fractures of the femoral neck. This figure is 56.3 per cent of all recorded fractures of the proximal end of the femur. Male patients (average age 66.3 years) accounted for 17.5 per cent of the total and females (average age 73.9 years) 82.5 per cent. The overall average age was 72.6 years and ages ranged from 16.7 to 96.7 years. Operations were carried out on 413 patients (92.6 per cent) and there were no emergency nailings. The majority of the fractures were fixed by means of Smith-Petersen nails and side-plates (49.4 per cent) or only with Smith-Petersen nails (45.4 per cent). In 10 cases (2.2 per cent) treatment was with primary prosthetic replacement. The primary mortality rate for fracture cases (within 30 days of the accident) was 12.3 per cent and the operative mortality rate was 9.4 per cent. A deep vein thrombosis which gave clinical symptoms occurred in 3.2 per cent of the patients. After nailing there was infection of the wound in

16 cases (4.0 per cent) and of these, 12 (3.0 per cent) had a superficial infection and four (1.0 per cent) a deep infection (cf. Nieminen 1974).

Post-operative treatment

Cases of fracture in the geographical area served by the University Hospital (representing a population of approximately 250,000) were first treated surgically either in the surgical clinic of the University Hospital or in the department of surgery of the Municipal Hospital. If beds were available, patients with fractures who were officially resident in Turku were treated post-operatively in the department of internal medicine in the Municipal Hospital. Weightbearing was allowed for these patients at an early phase, 2 weeks after nailing. Post-operative treatment of patients resident elsewhere was carried out in local institutions or at home and in these cases weightbearing after medial fracture of the femoral neck was not allowed until 12–24 weeks after nailing. Whether a patient bore weight early (i.e. in the Municipal Hospital) or late was therefore residence dependent, and in this sense haphazard.

Results of treatment

In the retrospective evaluation of the results of treatment, patients were divided as above into two groups—early weightbearing patients (EW, 2 weeks after operation) and late weightbearing patients (LW, 12–24 weeks after operation). Fractures were grouped both according to primary dislocation (Garden 1961) and according to the classical division of Pauwels (1935). The Pauwels division was completed by the addition of a fourth group (Leitz 1966). Those patients who were still alive and were adjudged, on the basis of an X-ray, to have had an insufficient follow-up (minimum period 2 years) were asked to come for a further examination. Bone union, failure (pseudo-arthrosis) and necrosis of the femoral head were defined on the basis of the ultimate X-ray in order to clarify results. Necrosis of the femoral head was defined on the basis of late segmental collapse of the femoral head (Barnes 1962, Bohr & Larsen 1965, Catto 1965 b).

RESULTS

Excluded from the groups of early (EW) and late (LW) weightbearing patients were those who died post-operatively or, on account of an accident, within 30 days. Table 1 shows the age distribution of patients and the number of fractures. There was no significant difference ($P > 0.05$) between the age distribution of the two groups. There were 63 EW cases (52.5 per cent) who were followed up for at least 2 years, the average period being 4.7 years (2.1–9.4). There were 80 LW cases (30.6 per cent) similarly followed up, the average period being 4.2 years (2.0–9.9).

Primary classification of fractures according to patient group is shown in Table 2. Dislocated fractures were almost significantly

Table 1. Average age of patient groups and number of fracture cases.

	Average age in years	Fracture cases
Early weightbearing patients		
(26.9 per cent of all fracture cases in the study)		
Men	65.1 ± 14.6	19 (15.8 %)
Women	71.8 ± 10.5	101 (84.2 %)
All patients	70.7 ± 11.4	120 (100.0 %)
Late weightbearing patients		
(58.5 per cent of all fracture cases in the study)		
Men	64.9 ± 13.5	50 (19.2 %)
Women	73.3 ± 9.8	211 (80.8 %)
All patients	71.7 ± 11.0	261 (100.0 %)

Table 2. Distribution of fracture types according to patient groups.

Classification		EW per cent	LW per cent
Garden	1	23.4	13.0
	2	2.5	1.5
	3	5.8	9.2
	4	68.3	75.5
Pauwels	1	3.3	2.3
	2	69.2	53.3
	3	24.3	40.2
	4	3.5	3.4

EW = early weightbearing patients, LW = late weightbearing patients.

($P < 0.05$) more numerous in the LW-group (Garden's 3rd–4th stage) and unstable fractures (Pauwel's 3–4) were significantly ($P < 0.01$) more numerous than in the EW-group. It will be seen, however, from Tables 3 and 4 that EW-patients showed better recovery than LW-patients irrespective of the type of fracture. Statistically, the greatest differences are to be seen in the largest groups. Among EW-patients, Garden's 4th degree fractures, in which bone union took place, were significantly ($P < 0.01$) more numerous than among LW-patients and similarly there were significantly more ($P < 0.01$) cases of bone union among EW-patients in the two groups of Pauwels' fractures than among LW-patients. If we consider the type of nailing used, fractures

Table 3. Progress of healing in early weightbearing patients in relation to various factors.

	Garden				Pauwels				Type of nail		Others
	1	2	3	4	1	2	3	4	S–P	S–P + side-plate	
Follow-up 2 years											
Cases	19	1	3	40	1	46	12	4	14	43	2
Bone union	19	1	2	37	1	43	12	4	13	40	2
Failed	–	–	1	3	–	3	–	1	1	3	–
LSC	2	–	1	12	–	14	1	–	4	10	1
Total											
Cases	28	3	7	82	4	83	29	4	23	87	4
No follow-up	2	–	1	13	1	9	6	–	3	12	2
Bone union	25	3	4	53	3	63	16	3	15	62	1
Failed	1	–	2	16	–	11	7	1	5	13	1
LSC	2	–	1	13	–	15	1	–	5	10	1

S–P = Smith-Petersen, LSC = Late segmental collapse of the femoral head.

Table 4. Progress of healing in late weightbearing patients in relation to various factors.

	Garden				Pauwels				Type of nail		Others
	1	2	3	4	1	2	3	4	S–P	S–P + side-plate	
Follow-up 2 years											
Cases	17	3	9	51	3	39	36	2	42	28	6
Bone union	16	2	7	40	2	38	24	1	34	22	5
Failed	1	1	2	11	1	1	12	1	8	6	1
LSC	1	1	2	16	1	10	8	1	9	8	2
Total											
Cases	34	5	24	197	6	139	105	9	141	92	16
No follow-up	5	1	1	48	1	36	17	–	33	16	3
Bone union	28	3	15	88	3	76	52	3	75	42	9
Failed	1	1	8	61	2	27	36	6	33	34	4
LSC	2	1	2	23	1	13	13	1	14	11	2

S–P = Smith-Petersen, LSC = Late segmental collapse of the femoral head.

Table 5. Progress of healing in the whole study, according to patient groups.

	Cases	No follow-up (per cent)	Bone union (per cent)	Failed (per cent)	LSC (per cent)
Follow-up 2 years					
EW	63	–	59 (93.6)	4 (6.3)	15 (23.8)
LW	80	–	65 (81.3)	15 (18.7)	20 (25.0)
Total					
EW	120	16 (13.3)	85 (70.8)	19 (15.8)	16 (13.3)
LW	261	55 (21.1)	134 (51.4)	71 (27.2)	28 (10.7)
		$P < 0.05$	$P < 0.01$	$P < 0.01$	$P > 0.05$
Together	381	71 (18.6)	219 (57.5)	90 (23.6)	44 (11.5)

LSC = late segmental collapse of the femoral head.
EW = early weightbearing patients, LW = late weightbearing patients.

Table 6. Late complications caused by the nail.

	EW (per cent)	LW (per cent)
Penetration by the nail of the surface of the femoral head	22 (19.0)	49 (19.7)
Sliding outwards of the nail	7 (29.2) •	30 (20.0) •
Collapse of the junction between nail and side-plate	8 (8.9) †	7 (7.1) †
Breaking of screws in side-plate	6 (6.7) †	6 (6.1) †
Breaking of side-plate	1	–
Breaking of nail	–	1

EW = early weightbearing patients, LW = late weightbearing patients.
• (per cent) Calculated from nailings without side-plate.
† (per cent) Calculated from nailings with side-plate.

treated with Smith-Petersen nails and side-plates failed very significantly ($P < 0.001$) more often among LW-patients than among those who were early weightbearers.

Fractures among EW-patients joined better (70.8 per cent) than those among LW-patients (51.4 per cent) and there were more failures among the latter group (27.2 per cent) than with EW-patients (15.8 per cent) (Table 5).

The differences were statistically significant but there were almost significantly more cases of LW-patients who had had insufficient follow-up than EW-cases. No difference could be observed between the two groups as far as necroses of the femoral head were concerned. In

Table 7. Perforations of the surface of the femoral head caused indirectly by the nail.

	Nail with side-plate	Nail without side-plate	
EW	21.1 per cent	12.5 per cent	$P > 0.05$
LW	33.3 per cent	10.7 per cent	$P < 0.001$
	$P < 0.05$	$P > 0.05$	

EW = early weightbearing patients, LW = late weightbearing patients.

Table 8. Progress of healing in patient groups according to time-lag between accident and nailing.

Date of nailing	Cases	No follow-up (per cent)	Bone union (per cent)	Failed (per cent)	LSC (per cent)
1–3 days					
EW	30	16.7	66.7	16.7	13.3
LW	76	23.7	46.1	30.3	13.2
		$P > 0.05$	$P < 0.05$	$P > 0.05$	$P > 0.05$
4–7 days					
EW	62	14.5	69.4	16.1	14.5
LW	129	22.5	55.8	21.7	10.1
		$P > 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$
> 7 days					
EW	22	18.2	72.8	9.1	13.6
LW	44	22.7	41.0	36.4	9.1
		$P > 0.05$	$P < 0.05$	$P < 0.05$	$P > 0.05$

EW = early weightbearing patients, LW = late weightbearing patients.
LSC = Late segmental collapse of the femoral head.

cases which were followed up for more than 2 years necroses of the femoral head were even relatively more common among LW-patients than among EW-patients.

There was no relative difference between the two groups as far as the number of complications arising from nailing were concerned (Table 6). Few symptoms generally resulted from the perforation of the surface of the femoral head caused by nailing. This type of complication (Table 7) was not aggravated by early weightbearing on the fractured limb, even in cases where a side-plate was used.

The time-lag between the accident and the nailing had no significant effect on the healing of the fracture, although in the EW-group in those cases where the fracture was nailed more than 7 days after the

accident, the joining was achieved relatively more rapidly than in cases where the nailing had been more prompt! In cases where the nailing had taken place between 1 and 3 or between 4 and 7 days after the accident, the healing of the fracture followed a similar pattern in both groups. In fractures that were not nailed until more than a week after the accident bone union occurred almost significantly more frequently and failed almost significantly less frequently among EW-patients than among LW-patients.

DISCUSSION

Early weightbearing on the injured limb after a medial fracture of the femoral neck has been considered justified because in many cases necrosis of the femoral head develops regardless of the fact that the patients have rested the limb. Furthermore, it is, in practice, often impossible to teach an elderly person to move around without putting weight on the injured limb and in any case patients often start using it on their own initiative without reference to the surgeon's instructions, and there has been no observable increase in the number of necroses of the femoral head. Sometimes there has been failure to diagnose subcapital fractures because patients have failed to consult their doctor and gone on bearing weight on the limb. Such impacted fractures usually heal excellently (Ainsworth 1971). Early weightbearing on the fractured limb has usually been in combination with low-angle nailing (Garden 1961, Smyth et al. 1964, Hullinger 1967, Ainsworth 1971). Fixation of a medial fracture by means of the classical nailing method (especially without side-plates) is technically a great deal easier than low-angle nailing. In the patients in this study nailings of medial fractures of the femoral neck were carried out in the classical manner, the nail being placed along the central axis of the femoral neck.

In addition to walking exercises, early weightbearing patients were given general therapy, which was lacking in the case of the late weightbearing patients. The latter, being either at home or in an old-people's home or in a local hospital, were unable to benefit from the services of a physiotherapist. It is difficult to estimate the real effect of general therapy on recovery in the case of medial fractures. On the other hand, merely the compression on the fracture caused by weightbearing can create the most beneficial conditions possible for bone union in the case of medial fractures of the femoral neck, principally in the can-

cellous bone, and also for the revascularization of the femoral head. Revascularization of the femoral head takes place mainly by way of the femoral neck (Catto 1965 a). Resorption of the bone, which occurs if the osteosynthesis is not completely stable (Perren et al. 1969), does not take place during compression on the fracture surfaces, but pressure heals and considerably accelerates union of the cancellous bone (Charnley & Baker 1952). It is clear that impaction caused by compression also stabilizes the fracture considerably (cf. Pauwels' results for fracture groups 3 and 4, Tables 3 and 4).

In the present study the results of treatment were considered in relation to particular variables and mainly on the basis of X-ray examinations. Because of the practical aims of the study this manner of proceeding may be regarded as well founded and in keeping with modern therapeutic methods. Moreover, in the case of medial fractures of the femoral neck, X-ray findings may be considered directly comparable to clinical results (Öhman et al. 1969). In the two groups of patients studied by Garden and Pauwels, fractures healed better among the early weightbearers than among the late weightbearers. The clearest differences were observed in Garden's 4th degree fractures, where bone union was achieved in 65 per cent of the EW-patients and failure was recorded in 18 per cent. The corresponding figures for late weightbearers were 45 per cent ($P < 0.01$) and 29 per cent, respectively. Although a relatively greater proportion of EW-cases than LW-cases were nailed with side-plates, the actual number of fractures fixed by this method was approximately the same in both patient groups. The results of treatment were considerably better, in the case of such fractures, in the EW-group than in the LW-group. Also in the case of patients whose fractures were nailed without a side-plate the proportion in which bone union was achieved was greater in the EW-group than in the LW-group. Thus, the type of nailing used had no effect on the results.

On the basis of clinical examination, early weightbearing on the limb after medial fracture of the femoral neck has been recommended by Moore (1937), Garden (1961), Bonnin & Cashman (1963), Smyth et al. (1964), Gibson (1964), Abrami & Stevens (1964), Hullinger (1967), Schiestel (1968), Graham (1968), Häggqvist (1969) and Ainsworth (1971). On the basis of the present study, early weightbearing plus nailing can be recommended as an appropriate treatment in the case of medial fractures of the femoral neck. Fixing a medial fracture by means of the classical nailing method is no great strain even for elderly

patients and should always be undertaken as the primary treatment, even in the case of a dislocated fracture. No significant differences could be observed in the results of treatment between fractures where the nailing was performed 1–3 days or 4–7 days after the fracture or even more than a week after the accident. In the case of fractures that were nailed more than a week after the accident, bone union was almost significantly more frequent and failure was almost significantly less frequent in EW-patients than in LW-patients. This can be interpreted to mean that the compression caused by weightbearing helps bone union in medial fractures of the femoral neck. In these cases, where there was a long period without reduction, it may be supposed that the extent of possible primary damage to the blood circulation and connective tissue was similar in all cases. No differences can be observed in the progress of healing between emergency operations for medial fractures of the femoral neck and those where nailing takes place later (Graham 1968). There thus seems no reason to perform emergency operations in the case of such fractures, but the first duty is to determine carefully the general state of health of the patient. Early post-operative mobility accompanied by weightbearing in the injured limb are an aid to recovery, help the patient to achieve autonomous movement more quickly and thus reduce the length of time the patient must remain in expensive hospitalization.

SUMMARY

This study is a survey of a series of 446 patients, treated in the city of Turku, Finland, between 1964 and 1971, for medial fractures of the femoral neck. Fractures were treated by means of the classical nailing method (nail placed along the central axis of the femoral neck, *ad modum* Smith-Petersen). An unselected group of patients were treated in such a way that they were already allowed to bear weight on the injured limb 2 weeks post-operatively (120 patients). The remaining patients were not allowed to bear weight on the injured limb until 12–14 weeks after nailing (261 patients).

The progress of recovery was studied retrospectively, a comparison being made between the early and late weightbearers. Without reference to the type of fracture (according to the classifications of Garden or Pauwels) or to the method of fixing (Smith-Petersen nail, with or without side-plate) bone union was relatively more frequent and failures were relatively less frequent among early weightbearers than

among late weightbearers. Early weightbearing had a beneficial effect upon the healing of the fracture and there was no evidence in the case of early weightbearers of any additional complications.

A comparative study of the whole patient group on the basis of the time-lag between the accident and the operation—some were nailed 1–3 days, some 4–7 days and some more than a week after the fracture had taken place—revealed no significant differences.

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