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TREATMENT OF FRACTURES OF THE FEMORAL SHAFT

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It has been claimed recently that no fixed principles apply to the treatment of femoral shaft fractures in adults, the choice of method depending upon the surgeon's experience and the armamentarium available in the hospital (Dencker 1968). Traction is still recommended by most workers (Brandberg 1958, Dencker 1965a, Harvey et al. 1968), but internal fixation has gained ground in special types of fracture. Most reports on this subject—including all those from Denmark (Madsen 1966, Horsnæs 1968, Tophøj & Sørensen 1968)—deal only with the results of one method and/or given types of fracture, so that the materials are selected (Küntschner 1940, Lauritzen 1949, Peterson 1950, Böhler 1951, Aronsson 1956, Palmer 1957, Smith 1964, Horsnæs, Tophøj & Sørensen, Rokkanen et al. 1969). This renders difficult any general assessment of this given type of fracture. Only a few have analysed their entire materials (Brandberg, Nichols 1963, Dencker 1965a). On this background we felt that the total therapeutic results in fractures of the femoral shaft in adults over a period of 10 years would merit publication, in particular as the results differ in several respects from previous reports.

MATERIAL

The material comprises 79 patients with 82 fractures of the femoral shaft from the 10-year period October 1958–October 1968 (Figure 1). The aetiology, traumatic in all cases, is specified in Table 1. The classification into types according to Dencker is listed in Table 2. Open fractures were present in 22 cases, making up one-quarter of the material. 27/82 fractures were components of multiple fractures.



Figure 1. Age distribution and sex ratio. 79 patients with fractures of the femoral shaft.

Table 1. Distribution of fractures by eliciting cause

Cause	Number of fractures	
	M	F
Traffic accident	53	6
Fall	5	12
Working accident	6	0
Total	64	18

METHOD

The therapeutic methods in relation to the level and type of fracture are shown in Tables 3, 4, and 5. Three patients are not included in this survey. Two of them were treated by non-weight-bearing, and the third died of other injuries shortly after the accident.

Table 2. Type of 82 fractures of the femoral shaft

Type	Number of fractures		Total
	Closed	Open	
Transverse fracture	17	8	25
Oblique fracture	21	3	24
Comminuted fracture	19	10	29
Double fracture	3	1	4
Total	60	22	82

Table 3. 37 fractures of the femoral shaft treated by Küntscher osteosynthesis and 3 treated by the method of Rush (in parentheses)

Intramedullary nailing				
Type of fracture	Level of fracture on the femoral shaft			Total
	Upper third	Middle third	Lower third	
Transverse fracture	—	22	(2)	24
Oblique fracture	—	6	—	6
Comminuted fracture	—	9	(1)	10
Double fracture	—	—	—	0
Total	0	37	(3)	40

Clover-leaf-shaped Küntscher nails of stainless steel were used. In 31/37 cases the osteosynthesis was done immediately. The open method with anterolateral access by exposing the bone ends and retrograde insertion of the guide was employed. Drilling of the medullary cavity—as described by Küntscher (1959) and Rokkanen et al. (1969)—was not used.

In the conservatively treated group the standard method was application of a Braun splint and wire traction through the tibial tuberosity.

Immediate osteosynthesis was done in 18/22 open fractures. Chemotherapy was given in the form of penicillin and/or streptomycin.

Table 4. 11 fractures of the femoral shaft treated by plate fixation (5 Hagglund, 1 McLaughlin, and 5 sliding plates)

Plate fixation				
Type of fracture	Level of fracture on the femoral shaft			Total
	Upper third	Middle third	Lower third	
Transverse fracture	—	—	1	1
Oblique fracture	1	2	—	3
Comminuted fracture	1	2	3	6
Double fracture	1	—	—	1
Total	3	4	4	11

Table 5. 28 fractures of the femoral shaft treated by traction

Traction				
Type of fracture	Level of fracture on the femoral shaft			Total
	Upper third	Middle third	Lower third	
Transverse fracture	—	—	—	0
Oblique fracture	1	4	8	13
Comminuted fracture	2	6	4	12
Double fracture	—	2	1	3
Total	3	12	13	28

POSTOPERATIVE TREATMENT

The group treated by osteosynthesis was gradually mobilized. During the first two weeks the limb was elevated on a Braun splint, and physical therapy was

instituted at once. This was followed by walking exercises in the pool and between bars, later with crutches until full weight-bearing was allowed at the time of clinical healing. In the conservatively treated group active exercises were started immediately. The traction was maintained until consolidation had taken place, and thereafter walking exercises were started as stated above.

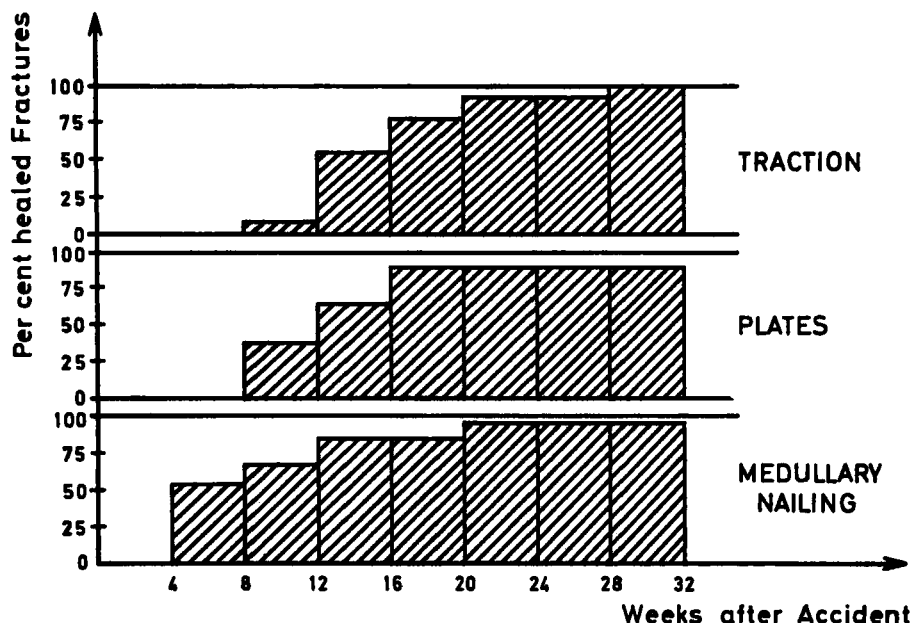


Figure 2. Healing time assessed for 77 fractures (excluding one patient who had amputation, two who died, and two treated merely by non-weight-bearing, a total of 5 fractures).

EARLY RESULTS

Healing Time and Duration of Stay in Hospital

As a criterion of healing the patient had to be able to stand on the leg without pain at the site of fracture which must have become consolidated, showing radiological union. By this criterion healing took place within 32 weeks except in three patients. Figure 2 gives the healing time for the three groups of patients.

Among the 27 fractures which were just one component of multiple fractures, the time of healing could be assessed in 26. Union had taken place in 20 cases within the 16th week and in all cases by the end of the 24th week.

Table 6. Average duration of stay in hospital, stating range

Group of pts.	Treatment	No. of pts.	Days
Patients with isolated fracture	Osteo-synthesis	30	61 (16-189)
	Traction	21	116 (90-175)
Patients with multiple fractures	Osteo-synthesis	18	109 (34-290)
	Traction	6	

The duration of stay in hospital is apparent from Table 6. Four patients—2 who died and 2 who had fissures—are not listed on this Table.

Complications

Table 7 lists the complications occurring in relation to the treatment. This Table does not include two patients who died: a 33-year-old man with multiple fractures as well as severe injuries to the abdomen and chest who died on the first day and a 78-year-old man with severe cardiac and renal failure to which he succumbed on the tenth day. High amputation was done in a patient with severance of the femoral artery and a severe crush injury of the leg. Because of lack of viability, the amputation had to be performed through the femoral fracture. These three complications are not ascribed to the fracture or its treatment.

LATE RESULTS

Follow-up

64 patients with 66 fractures attended follow-up in the winter 1968-1969. The remaining group of 15 patients will be reported in a separate section. The follow-up period ranged from 10 to 0.5 years, average 5 years. All follow-up examinations were performed by the authors. The results are given in Table 8. On the basis of the objective findings and the patients' subjective complaints the therapeutic results were grouped (Table 9) according to Dencker's classification (Table 10). The patient who underwent femoral amputation had no complaints and is not listed in the Tables giving the results of the follow-up.

Table 7. Postoperative course assessed for 79 fractures in relation to treatment

Treatment	Lethality	Infection	Unstable fixation of fracture	Amputation	Phlebitis	Emboli	Delayed union	Non-union	New fracture of the same femur
Medullary nailing	0	0	5	0	2	0	1	1	0
Plating	0	0	2	0	0	1	1	0	0
Traction	0	1	—	0	1	0	0	0	2

Table 8. Late therapeutic result in 65 fractures of the femoral shaft

Treatment	Shortening		Rotation		Angulation		Flexion in knee joint	Atrophy of thigh	
	1-3 cm	> 3 cm	10-20°	> 20°	10-15°	> 15°	< 90°	1-3 cm	> 3 cm
Medullary nailing	2	0	4	1	0	0	0	2	0
Plating	2	0	1	0	0	0	1	1	1
Traction	7	0	0	1	4	1	0	3	0

Table 9. Classification of late results according to Dencker

Result	Number of fractures			Total
	Medullary nailing	Plating	Traction	
Excellent or good	35	9	19	63
Satisfactory	0	0	1	1
Poor	0	1	0	1
Very poor	0	0	0	0

Table 10. Dencker's classification of late results in treatment of femoral shaft fractures

Result	Excellent or good	Satisfactory	Poor	Very poor
Discomfort	none or slight	moderate	severe	very severe
Shaft shortening	< 3 cm	< 5 cm	< 8 cm	> 8 cm (amputation)
Angulation	< 15°	< 20°	> 20°	Non-union
Flexion of knee joint	> 90°	> 45°	< 45°	
Instability in knee joint	0°	< 10°	> 10°	
Extension defect in knee joint	none	< 5°	> 5°	
Thigh atrophy	< 2 cm	< 3 cm	> 3 cm	

The osteosynthesis material was removed only in the group treated by medullary nailing, and in these cases at the end of one year.

Corrective Procedures

In the course of the follow-up period corrective treatment had been given in 8 cases: Quadriceps lysis in 3, brisement forcé of the knee in 2, corrective osteotomy in 1 because of osteoarthritis in the knee due to a 12° varus deformity after the healing of a low femoral shaft fracture. In 2 cases operation on a pseudarthrosis was carried out as a link in the treatment of delayed union. Four of the 5 patients who developed ankylosis of the knee joint had multiple fractures, including fracture of the homolateral lower leg in 3. All the corrective procedures afforded the desired results.

In a 43-year-old woman with a low open fracture of the femoral shaft and rupture of the quadriceps tendon, quadriceps lysis ought to have been done during the post-fracture period. However, the last part of the after-treatment had been given in another hospital, where this

procedure was omitted. Later, this patient was awarded a disablement pension.

Development of Osteoarthritis in the Hip or Knee

In 28 patients under 40 years of age the femoral fracture was an isolated fracture of the lower limb. The hip and knee joints were X-rayed at follow-up. In 4 cases—1 hip and 3 knees— followed for 6 to 9.5 years, unilateral osteoarthritis was demonstrated on the side of the injury. The X-ray films were compared with the films from the time of the accident when the osteoarthritic changes had not been present. All these patients had sustained their femoral fracture by being run over by cars. In 2, consolidation had taken place with slight to moderate deformity at the site of the fracture.

Socio-economic Status

This analysis comprised 33 working patients—including 5 women—under 60 years with isolated fracture of the femoral shaft. In 29 cases the social status was unchanged. One had been awarded disablement pension. Two had lighter work, although they did not have relevant complaints. One who had femoral amputation was rehabilitated and thereby obtained a higher social status.

The average period of illness was $8\frac{1}{2}$ months (2–24).

The Group Not Included in the Follow-up

This group comprises 15 patients with 16 fractures—one-fifth of the entire material. All but two, who died, had been followed in the department until healing took place. Eleven fractures healed without deformity and two with a $10\text{--}15^\circ$ varus deformity. One developed pseudarthrosis, but operation was performed with a favourable result.

At the time of follow-up, 8 of these patients were alive. 4 were unable to attend and 4 could not be assessed because of other disabling conditions. On inquiry and/or examination, none of these 8 patients had complaints that could be attributed to the femoral fracture.

DISCUSSION AND CONCLUSION

According to Key (1955) and Palmer (1962), transverse and short oblique fractures through the middle third of the femoral shaft make up the main indication for Küntscher nailing. Aronsson's experience

also speaks for a restriction of the indications. Out of our 37 Küntscher-nailed fractures, 22 fulfilled the criteria set up by Key and Palmer in respect to type and level of fracture. Of the remaining 15, 6 were flat oblique fractures and 9 slightly comminuted fractures in the middle third of the shaft. The four cases of instability at the fracture site after Küntscher nailing belonged to this latter group. Nail-impacting, reported in the literature at a rate ranging from 3 per cent (Palmer 1957) to 6 per cent (Dencker 1965b, Tophøj & Sørensen 1968), did not occur in our material.

Plate fixation was used for all cases of fractures not suited for medullary nailing. The procedure was employed in cases of multiple fractures and complicated fractures of the shaft. In special cases it was also used to attain early mobilization or as a link in the fixation of fractures which proved difficult to reduce.

Skeletal traction was the preferred treatment in cases where the type of fracture was not felt to be suited for medullary nailing and in which the above indications for plating were not present. In patients where another injury had therapeutic priority, plate fixation, though indicated in accordance with the above, was omitted if an instituted conservative treatment was believed to be able to afford a good result.

The low incidence of infections—one case—is remarkable in view of the relatively large number of open fractures and the use of open medullary nailing. Such a low rate has been reported only by Madsen, while others have had considerably higher rates (Böhler 1951, Palmer 1957, Dencker 1965a, Wickström & Corban 1967, Tophøj & Sørensen 1968, Horsnæs 1968). Sepsis has been reported as a complication to Küntscher nailing (MacAusland & Eaton 1963, Tophøj & Sørensen 1968).

On the basis of the present material, consolidation of the femoral fracture seems to have occurred earlier than reported by others (Nichols 1963, Smith 1964, Dencker 1965a, Rokkanen et al. 1969). However, regard must be paid to differences in the therapeutic principles and in the criteria of healing. Better conformity between the results is apparent from reports in which the time of return to work is stated (Nichols 1963, Rokkanen et al. 1969).

Charnley & Guindy (1961) as well as Smith advise delayed osteosynthesis in candidates for Küntscher nailing in order to avoid disturbances of union. In the present material the Küntscher osteosynthesis was done as an immediate procedure in the great majority of cases, without the result being characterized by delayed union or non-union.

Rokkanen et al. (1969) also found no difference in healing time after immediate and delayed medullary nailing.

The late results, classified according to Dencker (1965a), are given in Table 9. Unlike Dencker, we found no difference in the therapeutic results between closed and open fractures. The good results, compared with other materials classified according to Dencker (Dencker 1965a, Tophøj & Sørensen 1968) must be viewed, *inter alia*, on the background of the corrective procedures carried out during the follow-up period.

The frequency of osteoarthritic changes in the adjacent joints, interpretable with predominant likelihood as late sequelae of the trauma which caused the fracture, is not known. In the present material the frequency of secondary osteoarthritis in patients under 40 years of age may possibly prove to be too low if the follow-up period is extended. In two patients deformity at the fracture site is a possible aetiological explanation. Incidentally, this subject has not been elucidated in the literature.

On the basis of the present material it seems justified to conclude that the problem concerning fractures of the femoral shaft relates mainly to the choice of the correct form of treatment, paying regard to the character of the fracture concerned—presupposing that the technique and available armamentarium are optimal.

SUMMARY

A retrospective analysis of the results of treatment in fractures of the femoral shaft during a 10-year period is reported. The material is a traumatic one, comprising 79 patients with 82 fractures, 22 of which were open. One-third of the fractures were but one component in multiple fractures. Medullary nailing was done in 40 fractures, 37 with the Küntscher nail and three by the method of Rush. Plate fixation was used in 11 fractures and 28 were treated by traction. Two required only non-weight-bearing. One patient died of another cause on the first day. The early therapeutic results are reviewed.

At follow-up the late results could be assessed in 64 patients with 66 fractures. The follow-up period averaged 5 years. The result is stated on the background of subjective complaints and objective findings according to the classification of Dencker. A good result was obtained in all cases of medullary nailing. Out of 10 fractures treated by plate fixation, 9 obtained a good and one a poor result. Out of 20 cases treated by traction, 19 showed a good and one a satisfactory result.

The remaining group of 15 patients with 16 fractures is reported in a separate section. The late results could not be assessed, as a follow-up examination could not be performed. Eleven out of the 16 fractures united without deformity, 2 in slight varus deformity, and 1 developed pseudarthrosis. Seven out of the 15 patients died, 5 of old age and 2 in connection with the fracture-eliciting trauma, and the surviving 8 had no relevant complaints on inquiry.

Corrective procedures and delayed osteoarthritis of the hip and knee are discussed. The socio-economic status could be evaluated in 33 working patients.

A conclusion is advanced on the basis of the above findings.

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