Concurrent ipsilateral fractures of the hip and femoral shaft

A meta-analysis of 659 cases

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659 cases of concurrent, ipsilateral fractures in the hip and femoral shaft reported in 59 studies were analyzed. The causes were a road traffic accident in 78% and other types of high-energy traumas in 13% of the patients. This injury combination was rare in children. The median age was 34 years. 78% of the patients were men. One-third had multiple injuries, one-half had injuries of the ipsilateral knee and one-half had other lower limb injuries. The femoral neck fractures were most often basilar and the reported rate of avascular necrosis was 3%. The trochanteric fractures were intertrochanteric transverse, and seldom comminuted. The important factors in reducing morbidity were an early diagnosis of all injuries and efficient treatment of the shaft fractures. Locked intramedullary nails yielded results which were superior to combinations of plates or unlocked nails and separate hip screws. Reconstruction nails (cephalomedullary nails) gave results equal to those of customary locked nails and separate hip screws. The rate of healing of the hip fracture was over 99%, the treatment of the shaft fracture being of main importance for the outcome.

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Fractures of the femur concurrently in several locations are encountered in high-energy injuries, especially in road traffic accidents (Ravaglia and Zorzi 1955, Kulowski 1968, Rinaldi et al. 1989, Melis et al. 1990). Ipsilateral hip and shaft fracture is one of the commonest combinations and warrants special diagnostic considerations. Since the first reports (Becher 1951, Delaney and Street 1953), various methods of treatment have been used. However, only a few authors have experience from several cases. Over the years, new implants have become available to help solve problems of complex femoral fractures.

This meta-analysis deals with concurrent ipsilateral fractures of the hip and shaft. The types of fracture are analyzed and methods of treatment compared.

Material and methods

The meta-analysis was conducted according to existing guidelines (Gerbarg and Horwitz 1988). A comprehensive search in the Index Medicus from 1970 through 1994, supplemented by SilverPlatter 1983–June 1995, was performed concerning fractures of the femoral neck and trochanteric area concomitant with ipsilateral fractures of the femoral shaft. In addition to finding German and French studies and other studies prior to 1970, the reference lists of all publications were scanned. Duplicate publications of the same results were excluded. Selected references were used to clarify the mechanisms of injury, classification of fractures, and methods of treatment.

No population-based studies were found. All the studies were retrospective. Reports with at least 15 cases and sufficient information were analyzed for demographic data and data about mechanisms of injury (Table 1). All reported cases were included in the analysis of site and type of injuries (Table 2); some studies dealt only with femoral neck or trochanteric fractures.

In the analysis of treatment methods and outcomes a certain standardization of treatment policy was presupposed. To improve the methodology (Gerbarg and Horwitz 1988), only reports where at least 4 cases had been treated by the same method were selected (Table 3). None of the studies compared different treatment methods in a prospective, randomized way. However, pooling was used because the demographic and epidemiologic data were similar.

The results were classified as excellent, good, fair, and poor (Alho et al. 1991). Because of lack of data

Table 1. Demographic data and mechanisms of injury in ipsilateral hip and femur fractures in some large series[a]

A	B	C	D	E	F	G
Ravaglia and Zorzo 1955	10	41 (9–59)	8/ 2	7/ 3/ 0	3	1
Bernstein 1974	15	41 (26–76)	10/ 5	11/ 1/ 3	9	7
Casey and Chapman 1979	21	33 (16–61)	13/ 8	15/ 6/ 0	11	10
Wruhs et al. 1986	26	39 (16–74)	19/ 7	20/ 3/ 3	..	..
Friedman and Wyman 1986	24	37 (19–69)	16/ 8	18/ 6/ 0	14	15
Wu and Shih 1991	42	36 (16–59)	38/ 4	40/ 2/ 0	..	..
Wiss et al. 1992	33	27 (20–72)	27/ 6	31/ 2/ 0	..	..
Bennett et al. 1993	42	31 (8–70)	35/ 7	37/ 5/ 0	17	16
Combined data	213	34 (8–76)	166/47	179/28/6	48%	44%

A References
B Number of patients
C Age, median (range)
D Sex, male/female
E Trauma, traffic accident / other high-energy trauma / low-energy trauma (see text)
F Injuries in lower limb other than in ipsilateral acetabulum or knee
G Concurrent major injuries in other organ systems
[a] .. Missing data

on function in many reports, excellent and good results were combined (Table 3). They consisted of cases with healed fracture, no malunion, and no reported reduction of function. Fair results included malunion with shortening > 2 cm, malrotation > 20°, and malalignment > 10°. The result was designated as poor in cases of amputation, persistent nonunion, or need for crutches or walker.

The statistical analysis was made, using a two-dimensional contingency table and the relationships between the types of treatment and their results were tested by the Pearson chi-square test.

Results

The median age of the patients was 34 (8–76) years (Table 1). Two reports gave information on the frequency of the fracture combination related to all femoral shaft fractures. Dencker (1965) collected a consecutive series of 1003 femoral shaft fractures in Swedish hospitals over 3 years and identified 8 cases of fracture of the shaft and neck of the same femur, giving a rate of 0.8%. Wu and Shih (1991) reported 42 ipsilateral hip fractures among 1425 consecutive femoral shaft fractures in Taiwan, which gives a rate of 3%. Obviously the rate depends on the frequency of high-energy injuries in the population.

Types of hip fracture

The neck fractures, if possible were, divided into subcapital, midcervical and basilar. Basicervical location of the neck fracture was most frequent, occurring in 62% of all neck fractures (Table 2, Figure 1), and a real subcapital location with the fracture line medial to the midcervical transverse line of the neck could be identified only three times. The division into basilar neck and trochanteric fractures was not quite clear in all reports. The trochanteric fractures, according to illustrations in several reports (Dencker 1965, Wolfgang 1976, Alho 1980), were transverse, intertrochanteric, and seldom comminuted (Figure 2).

When the series where both cervical and trochanteric fractures were reported was used as the basis of calculation, trochanteric fractures had an average frequency of 28% of all ipsilateral hip fractures (Table 2).

Delayed diagnosis of the hip fracture

The percentage of missed primary diagnosis with a delay from one day to several months has been around 30 (Decoulx et al. 1965, Mackenzie 1971, Bernstein 1974, Moschinski et al. 1974, Nádor et al. 1975, Casey and Chapman 1979, Swiontkowski et al. 1984, Gill et al. 1990, Wiss et al. 1992). The frequency of delayed and missed diagnosis depended on the diagnostic routine of the hospital and on the type of fracture.

The rate of late diagnosis was low in hospitals where the routine included the hip in the radiographic study of every femoral fracture (Dencker 1965, Haas et al. 1980). Riemer et al. (1993) addressed the problem of the radiographic diagnosis of undisplaced fractures. In 10 of 32 instances, the diagnosis was made after fixation of the diaphyseal fracture. In 4 instances, the diagnosis was delayed for 3 days to 4 months after the trauma. In all these cases, the hip fracture was minimally displaced. They stated that the primary radiographs taken in the emergency room were inadequate for diagnosing all femoral neck fractures and recommended repeated controls. This is illustrated by one of our cases where the hips were

Table 2. Data in series of 659 ipsilateral, concomitant hip and shaft fractures[a]

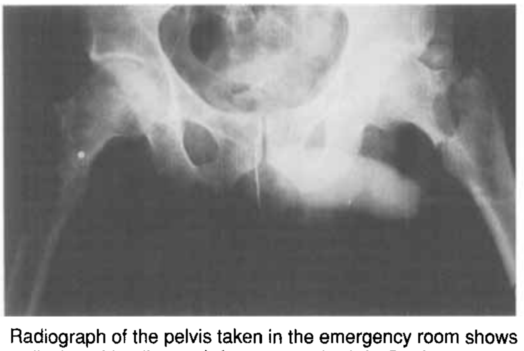
A	B	C	D	E	F	G	H	I	J
Becher 1951	1	1/–	–	–	–	1	1		–
Delaney and Street 1953	4	3/1	–	1	1	2	3	1	2
Ravaglia and Zorzi 1955	10 (9)	7/3	2	2	..	..	10		..
Heise 1957	3	..	..	..	..	..	3		..
Merle d'Aubigné and Lord 1957	6	..	..	–	3	1	4	2	..
Ritchey et al. 1958	2	..	..	..	..	..	1	1	1
Böhler and Aichner 1959	20	..	..	–	..	..	20		..
Koslowski and Rauch 1959	1	1/–	–	–				1	..
Aufranc 1961	1	–/1	–	–	1[b]	–	1		–
Kimbrough 1961	5	..	–	1	..	..	4	1	..
Spängler 1963	8	..	–	4	..	..	5	3	2
Lechner 1964	10	..	..	6	..	..	8	2	..
Decoulx et al. 1965	4	2/2	–	–	2	1	3	1	..
Dencker 1965	8	7/1	–	1	1	2	3	5	2
Lockhart et al. 1966	5	..	–	2	..	..	5		..
Olix 1967	2	..	..	–				2	..
Kulowski 1968	3	1/2	–	2	..	..	3		..
Schatzker and Barrington 1968	7 (6)	..	–	3	–	7	7		5
Krebs 1969	3	..	–	–				3	–
Tscherne et al. 1969	8	5/3	1	4	3	1	4	4	4
Fardon 1970	1	1/–	–	–	–	1	1		–
Mackenzie 1971	8	6/2	–	2	1	3	4	4	..
Viernstein et al. 1971	11	..	..	..	..	..	11		..
Horwitz 1972	2	–/2	–	–	..	..	2		2
Bernstein 1974	15	..	2	3	..	..	12[c]	3	5
Moschinski et al. 1974	3	2/1	–	–	–	3	3		..
Hoeksema et al. 1975	1	1/–	–	–	–	1	1		–
Mourgues et al. 1975	25	..	3	4	10	15[c]	25		..
Nádor et al. 1975	10	..	..	..	..	..	10		..
Wolfgang 1976	1	1/–	–	–	–			1	1
Ashby and Anderson 1977	2	2/–	–	–	–	1	1	1	–
Casey and Chapman 1979	21	..	3	4	8	4	12	9	9
Wright 1979	18	..	..	..	..	..	12	6	..
Alho 1980	20	..	1	-	7[b]	8	15	5	5
Haas et al. 1980	25	..	..	6	4	11	15	10	..
Carrett et al. 1981	1	1/–	–	–				1	–
Reiler and Vécsei 1981	4	..	..	..	..	..	4		..
Zettas and Zettas 1981	12	..	-	4	..	..	10	2	3
Wellin et al. 1984	4	..	–	1				4[c]	..
Barquet et al. 1985	13	..	1	1				13	6
Bucholz and Rathjen 1985	6	3/3	1	–	3	2	5	1	..
Wruhs et al. 1986	26	19/7	1	9	6	12	18	8	5
Friedman and Wyman 1986	24	..	-	5	..	..	10	14	8
Harryman et al. 1986	2	2/–	–	1	–	2	2		–
Farooque et al. 1988	5	..	2	–	2	3	5		..
Eiskjær et al. 1989	8	1/7	–	3	..	..	8		2
Geissler et al. 1989	12	..	..	–	..	..	6	6	..
Rinaldi et al. 1989	14	..	..	..	..	..	14	..	..
Gill et al. 1990	13	9/4	1	1	4	9	13		3
Melis et al. 1990	30	..	–	–	..	..	13	17	..
Daffner et al. 1991	51	..	..	..	..	..	20	31	51
Wu and Shih 1991	42	22/20	2	9	19	23	42		..
Bose et al. 1992	5	1/4	–	–	2	3	5		..
Wiss et al. 1992	33	15/18	3	5	11	22	33		..
Leung et al. 1993	16	6/10	–	3	5	7	12	4	..
Chaturvedi and Sahi 1993	17	..	..	2	..	..	17		2
Bennett et al. 1993	42	..	..	8	4[b]	33	37	5	16
Alho et al. 1995	3	3/–	–	–	1	–	1	2	–
Present case (Figure 3)	2 (1)	2/–	–	–	–	2	2		1
Total reported	659	129/89	23	97	98	170	456	183	190
Mean percentages [d]		59/41	6	18	27	45	72	28	61

A References
B Number of patients with unilateral injury; in bilateral cases the number of patients is given in parentheses
C Number and type of femoral shaft fracture, Winquist I–II / Winquist III–IV (Winquist et al. 1984)
D Number of segmental femoral shaft fractures
E Number of open femoral shaft fractures
F Number of midcervical neck fractures
G Number of basilar neck fractures
H Total number of femoral neck fractures (the series of Wellin et al. 1984 includes only trochanteric fractures)
I Trochanteric fractures (all series do not include trochanteric fractures)
J Number of knee injuries
[a] – No observations, .. missing data
[b] Indicates a case where the neck fracture was subcapital
[c] Indicates a case with concurrent acetabular fracture
[d] Calculated from the available numbers

Figure 1. Basilar fracture of the femoral neck is a typical fracture in combination with a concurrent shaft fracture and occurs in 58% of all neck fractures in this combination. The fracture line indicates an axial force without torsion.

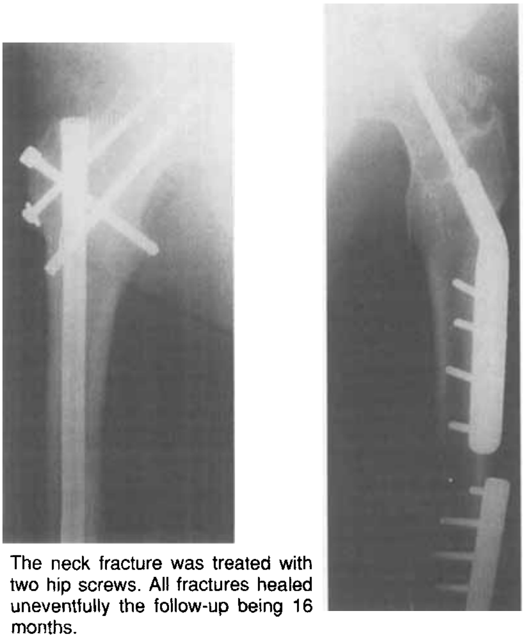
Figure 2. In ipsilateral hip and shaft fractures, a trochanteric fracture occurs in 28% of the cases. Typically, it is a noncomminuted intertrochanteric fracture caused by an axial force and buckling of the proximal femur. The lesser trochanter is usually intact and attached to the distal fragment.

Figure 3. A 29-year-old man sustained bilateral injuries of the femur, fractures of the left lower arm and hand, and retroperitoneal bleeding when his motorcycle collided head-on with a car.



Radiograph of the pelvis taken in the emergency room shows a displaced basilar neck fracture on the left. On the right, no fracture can be seen. In addition, he had bilateral femoral shaft fractures.

The left distal femoral shaft fracture was fixed with a 16-hole angled blade plate and the neck fracture with a sliding hip screw. The right Type I open femoral shaft fracture was treated with a locked intramedullary nail. The postoperative radiograph showed a slightly displaced, vertical midcervical fracture on the right.



The neck fracture was treated with two hip screws. All fractures healed uneventfully the follow-up being 16 months.

studied according to our routine in femoral fractures (Figure 3).

In 9 of 33 cases reported by Wu and Shih (1991), the fracture fixation was performed within 3 days after trauma and in 24 cases later. Their only case of avascular necrosis was among the latter patients, the follow-up being, on average, 2 years. Swiontkowski et al. (1984) reported a delay in the diagnosis of neck fracture in 3 of 15 cases, 2 of them being diagnosed after operative fixation of the diaphyseal fractures. Bennett et al. (1993) fixed 17 of 37 femoral neck fractures after 1 week; 1 of 3 femoral neck nonunions were among these patients. They had no nonunions. Thus, no complication could be specifically associated with the delay in the diagnosis of hip fracture. A cost factor and a disadvantage for the patient was the need for a later separate operation. Some nonunions resulted from a totally missed diagnosis during the primary care.

Table 3. Treatment of ipsilateral, concurrent hip and femoral shaft fractures in series where at least 4 cases were treated by the same method

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Conservative													
Mackenzie 1971 [e]	4	–	2	–	–	–	–	–	2	–	2	2–66	2/2/–
Bernstein 1974 [e]	4	–	2	–	2	–	1	–	4	–		..	2/2/–
Casey and Chapman 1979	7	–	1	–	–	–	–	–	2	–	5	5–40	6/1/–
Sum	15	–	5	–	2	–	1	–	8	–	7		10/5/–
Ender nails and pins													
Casey and Chapman 1979	5	1	2[f]	–	–	–	–	–	3	–	2	10–14	3/2/–
Geissler et al. 1989	4	1	–	1	–	–				1	4	20–39	2/–/2
Sum	9	2	2	1	–	–	–	–	3	1	6		5/2/2
Plate and screws [a]													
Bernstein 1974	7	–	2	–	1	–	–	–	7			..	5/2/–
Mourgues et al. 1975	10	–	–	6	–	–	–	–	10			>12	4/–/6
Casey and Chapman 1979	6	–	–	–	1	–	–	–	5	–	1	19–54	6/–/–
Alho 1980	14	2	–	2	2	–	–	–	9	–	5	12–84	12/–/2
Zettas and Zettas 1981	7	–	–	–	–	–	–	–	5	–	2	..	7/–/–
Wellin et al. 1984	4	–	–	–	–					–	4	5–8	2/2/–
Barquet et al. 1985	7	–	–	–	–					1	7	12–179	5/2/–
Farooque et al. 1988	5	–	–	–	1	–	1	–	5			6–28	3/2/–
Swiontkowski et al. 1984	4	–	1	–	–	–	–	1	4			..	3/–/1
Geissler et al. 1989	8	–	–	–	–	–	–	–	6	–	2	12–60	8/–/–
Wu and Shih 1991	10	3	–	–	–	–	–	–	10			13–45	10/–/–
Sum	82	5	3	8	5	–	1	1	61	1	21		65/8/9
Intramedullary nail [b]													
Delaney and Street 1953	4	–	1	–	–	–	–	–	3	–	1	4–21	3/1/–
Dencker 1965	5	–	1	–	1	1	–	–	4	–	1	..	3/1/1
Mourgues et al. 1975	8	–	–	–	–	–	–	–	8			>12	8/–/–
Alho 1980	5	–	1	–	–	–	–	–	5			12–84	4/1/–
Swiontkowski et al. 1984	10[g]	–	–	–	–	–	–	1	10				9/–/1
Wu and Shih 1991	20[h]	1	–	2	1	2	–	1	20			12–75	17/–/3
Bennett et al. 1993	21	–	3	–	–	2	1	–	19	–	2	13–126	18/3/–
Sum	73	1	6	2	2	5	1	2	69	–	4		62/6/5
Locked intramedullary nail [c]													
Bucholz and Rathjen 1985	6	–	–	–	–	–	–	–	5	–	1	..	6/–/–
Wruhs et al. 1986	20[i]	–	–	–	1	–	1	–	15	–	5	avg 27	19/1/–
Wiss et al. 1992	6	–	–	–	–	–	–	–	6			16–53	6/–/–
Leung et al. 1993	16	–	–	–	–	–	1	–	12		4	18–36	15/1/–
Sum	48	–	–	–	1	–	2	–	38	–	10		46/2/–
Locked nail, opposite-sided													
Wiss et al. 1992	13	1	1	–	–	4	1	2	13			12–71	9/2/2
Sum	13	1	1	–	–	4	1	2	13				9/2/2
Cephalomedullary nail													
Bose et al. 1992	5	–	–	–	–	–	1	–	5			13–28	4/1/–
Wiss et al. 1992	14	1	–	–	–	2	–	–	14			12–36	14/–/–
Bennett et al. 1993	6	–	–	–	–	–	–	–	6			16–30	6/– /–
Sum	25	1	–	–	–	2	1	–	25				24/1/–

A Treatment method and references
- [a] Plate in the shaft; screws, compression screw plates, nails or pins in the femoral neck
- [b] Intramedullary nail in the shaft; screws, nails or pins, sometimes compression screw plate for the femoral neck
- [c] Locked intramedullary nail for the shaft, separate screws or pins for the neck
- [d] Locked nail on the opposite side with a cortical screw through the nail, and additional neck screws

B Number of cases (and shaft fractures)
C Reoperations of shaft fracture (removal of implant not included)
D Malunions of shaft (shortening > 2 cm, malrotation > 20°, malalignment > 10°)
E Nonunion of shaft
F Deep infection
G Reoperation of femoral neck (removal of implant not included)
H Malunion of femoral neck (see D), no reported nonunions
I Avascular necrosis of femoral head
J Number of femoral neck fractures
K Nonunion of trochanteric fracture
L Number of trochanteric fractures
M Follow-up (months)
N Results: Excellent–good / fair / poor (see text)

[e] 1 case of pinned neck fracture
[f] 1 patient with leg lengthening by 2 cm
[g] Intramedullary nailing made retrograde from medial condyle
[h] 10 Huckstep nailings, 9 closed and 1 open Küntscher nailing
[i] Locked nail on the same side, or nail on the other side with the locking screw driven into the femoral neck were used, both with additional neck screws

Avascular necrosis of the femoral head

Circulatory problems in the femoral head were rare. The extent of displacement was seldom stated in the reports. In 153 cases with femoral neck fracture, the follow-up was 1 year or more (Table 3). Adding 14 cases of Swiontkowski et al. (1984) with a follow-up of less than 1 year in some cases, 5 instances of avascular necrosis could be identified, a rate of 3%. The avascular necroses were not associated with the delay in diagnosis or the time of operation. Eiskjær et al. (1989) reported 2 avascular necroses in a series of 8 concomitant neck and shaft fractures; the reduction of the femoral neck fracture was insufficient in both cases. Wiss et al. (1992) reported 13 ipsilateral neck and shaft fractures where the threaded, oblique, proximal screw of the locked nail was used to fix the femoral neck fracture in a reversed manner; 2 of these cases ended with avascular necrosis. These figures are too small to provide statistical evidence of the effect of the fracture reduction or type of treatment on the occurrence of avascular necrosis.

Treatment techniques and outcome

Series where at least 4 patients were treated by the same method are presented in Table 3. A general observation is that complications and reduced function resulted from the shaft fracture component.

Closed treatment, consisting usually of skeletal traction through the tibial tubercle followed by a spica cast, was performed in 15 cases. The trochanteric fracture was treated conservatively in a number of cases (Mackenzie 1971), but the neck fracture was always fixed. It seems that complications were commoner with closed treatment than with open treatment, and the cost benefit ratio was high. Conservative series have not been reported since 1979.

Intramedullary nailing with multiple flexible Ender nails has also been used in the combined fractures (Casey and Chapman 1979). In some cases, supplementary pins were placed in the neck. The Ender nails did not control the fractures and malunions and non-unions were common. The technique has not been in wider use. It seems that this method cannot yield results that are as good as those with the other types of internal fixation presented below.

Screw or screw-plate fixation of the hip and plate fixation of the shaft are obvious choices for the ipsilateral fracture combination. The reported cases totalled 82. The AO/ASIF techniques dominated. The treatment of the hip fracture was uncomplicated; only one avascular necrosis of the femoral head was reported in 61 neck fractures and one malunion in 21 trochanteric fractures. Therefore, the outcome depended mainly on the result of the treatment of the shaft fracture. The numbers of reoperations (5), malunions (3), nonunions (8), and infections (5) correspond to the figures found in series of solitary femoral shaft fractures. The results of plate fixation were similar to the results of unlocked Küntscher nailing of the shaft, combined with screw fixation of the hip.

A combination of intramedullary nailing of the femoral shaft and screw or pin fixation of the femoral neck has been the inevitable choice in cases where the hip fracture was undiagnosed at the time of nailing (Figure 3) and it was, therefore, fixed with the nail in place. The results have been favorable and this procedure has also been used as a primary choice (Haas et al. 1980, Wu and Shih 1991). The method has also been successful in 2 cases of trochanteric and shaft fracture (Delaney and Street 1953, Dencker 1965). It has been recommended that the screws should be inserted behind (Mourgues et al. 1975) or in front of the nail (Bucholz and Rathjen 1985). Obviously, the main rule is to insert the screws into the femoral neck and in a more or less parallel fashion. Many institutions have used both plates and nails for the shaft fractures, which indicates the difficulty of choosing. The problems in 73 combined pinnings and nailings—1 reoperation, 6 malalignments, 2 nonunions, and 2 infections of the shaft, and 5 reoperations, 2 malunions, 1 avascular necrosis, and 1 nonunion of the hip—were less than in the plate fixations and the outcomes of shaft fractures were marginally better, but no significant differences could be found between these two methods of fixation (Table 3).

The exactitude of intramedullary nailing of the femoral shaft fracture was increased considerably by the interlocking bolt techniques, which improved the rotational stability and prevented shortening of comminuted fractures (Alho et al. 1991). When ipsilateral hip and shaft fractures have been treated by this method, the screws have been inserted as described above. There were 1 infection of the shaft and 2 malunions of the hip among 48 operations. Fair and poor results were significantly fewer after locked nailing than after plate fixation (p 0.02), but only marginally fewer than after unlocked nailing (p 0.1). The same was true of the numbers of reoperations: they were marginally fewer after locked nailing than after plate fixation (p 0.08) or unlocked nailing (p 0.04).

The oblique direction of the threaded proximal locking screw of several nail designs made some authors use it for femoral neck fixation in a reversed fashion (right-hand nail on the left-hand side). A systematic analysis of the series of Wiss et al. (1992) revealed drawbacks in this technique. There were several problems with the femoral neck fractures—4 reoperations, 1 malunion, and 1 avascular necrosis in 13 operations, obviously because the threaded screw did not allow telescoping of the hip fracture and probably even caused distraction. The results of this treatment were inferior to the results of regular locked nailing and separate hip screws (p 0.006).

The newest development in the intramedullary nail devices for femoral fractures is to use hip screws for the proximal locking in so-called second generation locked nails (reconstruction or cephalomedullary nails). Several modifications of the design by Russel and Taylor (Bose et al. 1992) exist today. The hip screw or screws slide in the hole(s) of the nail. The screws in the nail give this design a strength against bending that the previously used combination of nail and separate screws does not have, which makes it suitable also for the combination of trochanteric and shaft fractures. Out of 25 cases, 1 shaft fracture and 1 hip fracture required a reoperation and there were 2 malunions of the hip. The results were not better than those of the first-generation locked nail with separate screws.

When the results of the first- and second-generation locked nails were combined, significant differences were found. The results were better than those of plate fixation (p 0.004) and unlocked nailing (p 0.04).

Discussion

In contrast to the common solitary hip fractures, concurrent injuries of the hip and shaft are sustained in high-energy trauma, the male sex dominates, and most patients are young, as in cases of solitary femoral shaft fractures (Alho et al. 1991) (Table 1). However, only 4 cases have been reported in children (Ravaglia and Zorzi 1955, Fardon 1970, Hoeksema et al 1975, Bennett et al. 1993). Bilateral lower extremity injuries are often combined with these injuries (Koslowski and Rauch 1959, Kulowski 1968). However, bilateral neck and shaft fractures have been reported only 3 times (Figure 3).

In car drivers and front seat passengers, concurrent, ipsilateral fractures of the hip and femoral shaft can be traced back to a dashboard injury, and injuries in the knee region are common (Table 1). The exact type of injury depends on the force distribution due to the form of the dashboard, its relation to the knee, and the position of the femur in relation to the pelvis (Heise 1957, Aichner 1958, Ritchey et al. 1958, Alho 1980). In a longitudinal compression, the femur either buckles and bends or crushes on impact. In the hip, the injury may be dislocation or fracture of the hip or acetabular fracture, depending on whether the femur is in an adducted, neutral, or abducted position. In a sagittal, neutral position of the femur, the head hits against the strong dome of the acetabulum and the hip is fractured (Alho 1980). Although the trauma mechanism is more difficult to analyze in falls from heights (5 m or more), pedestrian accidents, and motorcycle accidents, a force acting along the femoral axis seems a pausible explanation. Similar hip and shaft fractures have been found in static and dynamic cadaver tests (Evans et al. 1951, Ravaglia and Zorzi 1955, Alho et al. 1988).

On the basis of reports with sufficient data, the basicervical location of the neck fracture was most frequent, occurring in two thirds of neck fractures, while midcervical fractures occurred in one third and a real subcapital location with the fracture line medial to the midcervical transverse line of the neck could be identified only 3 times (1%). Among low-energy fractures, the undisplaced fractures are subcapital (Garden 1961), while the undisplaced buckling fractures in dashboard trauma are basilar (Zettas and Zettas 1981, Wu and Shih 1991, Riemer et al. 1993). Obviously, the classifications by Pauwels (1935) and Garden (1961) were made for low-energy fractures and are not suitable for the classification of the hip injuries in the concomitant hip and shaft fractures.

Unexpectedly, the rate of avascular necrosis was low, 3%, in the neck fractures. For comparison, the rate of avascular necrosis in solitary femoral neck fractures in a similar age group was 10% (Gerber et al. 1993). Calandruccio and Anderson (1980) pointed out that blood circulation is seldom jeopardized in lateral femoral neck fractures. Another explanation is the force dissipation in the shaft fracture.

In series where both cervical and trochanteric fractures were reported, the latter fractures had an average frequency of 28% (Table 2). Here, a terminology inconsistency is obvious, and trochanteric fractures are sometimes called cervicotrochanteric or basilar neck fractures (e.g., Figure 12 in Bernstein 1974). The trochanteric fracture, again consistent with the axial force direction, is usually transverse, intertrochanteric, and seldom comminuted (Dencker 1965, Wolfgang 1976, Alho 1980) (Figure 2).

The diagnosis of hip fracture was late in one-third of the cases in some series. One reason was an inadequate routine in taking primary radiographs (Dencker 1965). The other was the imperceptible nature of the femoral neck fracture which is often undisplaced and difficult to detect on emergency radiographs (Riemer et al. 1993). The diagnostic difficulties are accentuated in multitrauma patients (Figure 3). The best routine is to take a pelvic radiograph together with a chest radiograph on all multitrauma patients and in all studies of femoral shaft fractures. The use of an image intensifier during operative fixation also makes it possible to examine the hip. A complete diagnosis before the fixation of the shaft fracture is important, not only because it permits treatment of the fractures in the same session but also for medicolegal reasons, because a femoral neck fracture may occur as a complication of intramedullary nailing of the shaft fracture (Harper and Henstorf 1986, Christie and Court-Brown 1988, Alho et al. 1991).

In the reports from 1953 to the late 70s, the treatment of ipsilateral hip and shaft fractures varied from a fully closed regimen with traction of both components to operative fixation of one or both of the fractures. Becher (1951) and Delaney and Street (1953) in the two oldest reports used a combination of intramedullary nail for shaft and pins for femoral neck—a construction which became popular after the development of locking fixation of the intramedullary nail. Still in 1986, Friedman and Wyman found no uniformity in the treatment in the United States. Uniformity was commoner in Europe, where rigid fixation of femoral shaft fractures in adults, most often by intramedullary nailing, had been the rule for a long time (Becher 1951, Decoulx et al. 1965, Mourgues et al. 1975, Alho 1980, Wruhs et al. 1986).

A general observation when looking at the results presented in Table 3 is that hip fractures heal fairly easily with any other method than the use of a proximal locking screw of the opposite side nail as a hip screw, and that the healing of the shaft fracture is the main issue (Table 3).

Plate on shaft and sliding hip screw or separate screws in hip has been a reliable method which has yielded results similar to those of unlocked reamed intramedullary nail and separate neck screws (Table 3). The plate series was associated with more frequent infections and nonunions, while the nail fixations were complicated by rotary malalignments and shortenings, as has been the case in the treatment of solitary femoral shaft fractures.

If the nail is introduced in antegrade fashion from the tip of the trochanter, it does not allow a screw-plate fixation of a trochanteric fracture and even screw fixation of the neck may be problematic. Therefore, retrograde nailing has been recommended (Swiontkowski et al. 1984). However, since femoral shaft fracture is the key component, it is reasonable to deduct that retrograde nailings, especially those requiring an open technique, can be recommended as little as for isolated shaft fractures.

Locking of intramedullary nails improved the results significantly compared to unlocked nailings and, therefore, indirectly compared to plates and screws. Theoretically, as pointed out by Bennett et al. (1993), driving in an intramedullary nail adjacent to an unstabilized femoral neck fracture might jeopardize the blood circulation of the femoral head. According to the present meta-analysis, this has not been the case. Obviously, the fixation of a trochanteric fracture may remain unstable when using nail and separate hip screws.

The oblique proximal locking screw of some nail designs (nail on the opposite side) would seem to be a useful hip screw. However, Wiss et al. (1992) reported unfavorable results and concluded that the threaded screw prevents impaction of the neck fracture.

After the introduction of cephalomedullary nails (so-called second-generation locked nails), where the hip screws are inserted through the nail, any concomitant hip and shaft fracture can be fixed with a single implant (Bose et al. 1992, Bennett et al. 1993, Alho et al. 1995). This is an advantage which makes the treatment of trochanteric hip fractures also possible (Alho et al. 1995). On the other hand, as Bennett et al. (1993) pointed out, it may be difficult to align rotationally the nail and proximal locking holes, which may result in displacement of the neck fragment. While locked nails, in general, have yielded significantly better results than plates or unlocked nails, the reports are still too few for a reliable comparison of the conventional locked nails and the second generation nails. However, the results of second generation nails confirm the favorable results obtained with conventional locked nails for plates and separate screws.

Recently, adult respiratory distress syndrome has been reported in connection with intramedullary nailing in patients with multiple injuries (Wenda et al. 1988). The present data do not allow a reliable analysis of the effect of the time or type of operation on the rate of pulmonary complications.

In a recent review, Bucholz and Jones (1991) stated that the few published series are inadequate for determining which method of fixation yields the best results. My report shows the power of a meta-analysis in complex situations, where the cases per report are few and the treatment methods vary. The demographic and epidemiologic data in the total material show a reasonable homogeneity which seems to match the quality of a multicenter comparison of any other type.

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