Ipsilateral fractures of the femoral neck, shaft and distal end: long-term outcome of five cases

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Received: 26 May 2010 / Revised: 18 July 2010 / Accepted: 19 July 2010 / Published online: 14 August 2010
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Abstract Out of 52 cases of ipsilateral femoral fractures treated at a level I trauma centre between June 1994 and March 2008, the diaphyseal fracture was accompanied by a intracapsular neck fracture in only 20 cases. In the rest of the cases, the diaphyseal fracture was combined with either an extracapsular or pertrochanteric fracture. Five of these patients also had fractures of the distal femur. In three of those patients we began treatment with osteosynthesis of the femoral neck and shaft, using a reconstruction nail, then stabilised the distal fracture with a 95° blade plate or with lag screws. In the other two cases, initial treatment dealt with the distal femoral fracture, fixing it with a 95° blade plate, which was also used for stabilisation of the diaphyseal fracture. In these patients, the proximal fracture was treated using dynamic hip screws (DHS). All fractures healed, two after initial treatment, while the other three needed one revision. The follow-up period was 2–13 years after the injury. The order in which fractures are treated is best left to the discretion of the physician and the circum-

stances. In our experience, two implants are sufficient for osteosynthesis, one for stabilising one end of the femur together with the shaft, and the other is used for treating the other end of the femur.

Introduction

Fractures of the proximal femur, femoral shaft and distal femur occur, in combination, very rarely. This type of trauma was first described in 1993 by Käch [6], and we found 13 additional cases which have been published in the literature since. The injury is often the result of high-energy trauma such as motor vehicle accidents, falls from height, and pedestrian versus motor vehicle accidents and usually occurs in young patients [2, 3, 6, 7, 10]. The presumed mechanism of injury requires that the hip be flexed and abducted to a degree that the femoral head is well-seated within the acetabulum. The load is initiated at the knee and then applied longitudinally along the femoral shaft [2, 3, 5, 7].

Multifocal fractures of the femur present difficult fracture management issues because the preferred implant for one fracture may not be the preferred treatment for the other [1]. Numerous surgical fixation constructions have been described to manage this type of injury, although evidence for which to choose is lacking. The sequence of fracture treatment remains an important (and still unanswered) question. All of the authors strongly emphasised an individual approach to the treatment of these injuries [2, 3, 5–7, 10].

In our department, 52 patients with femoral shaft fractures combined with proximal femoral fractures were treated between June 1994 and March 2008. Five of these patients also had fractures of the distal femur (results from

The study was supported by a Grant from the Ministry of Health of the Czech Republic (IGA MZ NR 8853-4/06).

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the first case were published in 2000 [3]). All fractures were classified according to the AO/ASIF classification [9].

Four out of these five patients had long-term follow-up that ranged from five to 13 years; the fifth patient had a follow-up period of two years.

In this article we would like to share our experience regarding treatment and follow-up of patients with this rare and complicated type of injury.

Materials and methods

At our department, which is a level I trauma centre, 52 patients with femoral shaft fractures combined with proximal femoral fractures were treated between June 1994 and March 2008. All patients were older than 18 years of age. Out of 52 cases of ipsilateral femoral fractures, the diaphyseal fracture was combined with an intracapsular neck fracture in 20 cases. In the remaining cases, the diaphyseal fracture was combined with either an extracapsular or a pertrochanteric fracture.

Five of these patients also had fractures of the distal femur. Fractures were classified according to the AO/ASIF classification system [9]. We recorded, for all patients, demographic data, mechanism of injury, Injury Severity Score (ISS), timing of stabilisation, methods of reduction, sequence of fixation, types of implants, complications and their solution, final radiological and clinical outcome.

Results

There were four male and one female patient, ranging in age from 26 to 51 years. The mechanism of injury was always high-energy trauma involving a motor vehicle accident, resulting in polytrauma. The ISS ranged from 10 to 34. Four patients had closed fractures; one patient had an

open distal femur fracture. The right lower extremity was injured in four cases and the left lower extremity in one case. Patellar fractures complicated the femoral fractures in two patients. Fracture classification was according to AO/ASIF and is summarised in Table 1. There were two neck fractures (31-B2), one intracapsular and one extracapsular, and three stable pertrochanteric fractures (31-A1). Both femoral neck fractures had a vertical orientation. All femoral shaft fractures were in the middle third of the shaft: one was transverse (32-A3), two were oblique with interfragments (32-B2) and two were complex fractures (32-C1 resp. C3). Two of the distal femoral fractures involved only one condyle (33-B) while the other three were complete articular fractures (33-C). One of the unicondylar fractures involved the medial condyle (33-B2) and the other was a fracture of the lateral condyle in the frontal plane (33-B3) combined with an impact medial condyle fracture. Of the three complete articular fractures two were simple (33-C1) and one was a multifragmentary fracture (33-C3).

Table 2 summarises fracture treatment, complications and their solutions, follow-up and signs of post-traumatic knee arthritis. In three patients, initial treatment involved osteosynthesis of the femoral neck and shaft, using a reconstruction nail (Long Gamma nail Howmedica, PFN long Synthes, PFH long Medin). Thereafter, we stabilised the distal fracture with 95° blade plate or with lag screws (Figs. 1 and 2). However, in two cases, initial treatment was directed towards the distal femoral fracture, stabilising it with the help of a 95° blade plate, which, at the same time, dealt with the diaphyseal fracture. In these patients, the proximal fracture was treated using dynamic hip screws (DHS; Synthes; Fig. 3).

Healing of femoral fractures was uncomplicated in one patient (case 3). Additionally, in a case where shortening of the femur by 2 cm was inevitable (due to a comminuted zone in the diaphyseal region), the fractures healed well (case 4). Healing in the other three cases was more

Table 1 Injury details

Injury details	Patients				
Case/side	1/right	2/right	3/right	4/right	5/left
Cause of injury	MVA driver	MVA driver	MVA driver	MVA passenger	Motorcycle
ISS	22	9	34	34	34
Other injuries	Polytrauma 42-A2 sin.	31-A1+32-B3 sin. 42-A3 dx.	Polytrauma 43-C2 bilat.	Polytrauma 32-C1 sin. 43-C2 sin.	Polytrauma 22-C3 bilat. 23-C3 bilat.
Fracture classification					
31-	A1	B2	A1	A1	B2
32-	A3	B2	C1	C3	B2
33-	C1	C1	B2	C3	B2
Patellar fracture	+ open	–	–	–	+ open

ISS Injury Severity Score, MVA motor vehicle accident

Table 2 Treatment, complications, reoperations, knee arthritis, follow-up

Details	Patients				
Case/side	1/right	2/right	3/right	4/right	5/left
Treatment					
31-	Gamma long	DHS	PFN long	DHS	PFH long
32-		95°condylar plate		95° condylar plate	
33-	95°condylar plate		6.5-mm screws		6.5-mm screws
Patellar fracture	cerclage	—	—	—	cerclage
Complications	Dist. femur valgus	Diaphyseal malunion	Knee instability	Leg shortening	Diaphyseal nonunion
Reoperation	Varus osteotomy	Bone grafting	0	0	Renailing
Knee arthritis	++	++	++	+	0
Follow-up	13 years	10 years	7 years	5 years	2 years

DHS dynamic hip screws, *PFN* proximal femoral nail

involved. There was one case of malunion of diaphyseal fracture (Fig. 3), which required cancellous bone grafting (case 2). There was one case in which the distal locking screws of the reconstruction nail broke (Fig. 2), which resulted in a fracture nonunion (case 5). This problem was resolved by re-nailing with reamed femoral nail. And there was one case in which the fracture of the distal femur was stabilised in 20° of valgus (case 1); this was corrected via a supracondylar femoral osteotomy. All fractures healed, two after initial (primary) treatment, while the other three required a single additional operative intervention.

The follow-up period was 2–13 years after the injury.

Apart from the distal femoral fracture, the knee joint was also damaged in three patients. In two cases a fractured patella required osteosynthesis, and in one patient the internal collateral and anterior cruciate ligaments were

ruptured. In long-term follow-up, four of the five patients developed signs of post-traumatic knee arthritis.

Discussion

The combination of fractures to both the proximal femur and femoral shaft is an infrequent injury. It was first described in 1951 by Becher [4] as a typical high-energy trauma. The situation in which these two femoral fractures are further complicated by a distal femoral fracture is extremely rare.

The first one was described by Käch [6] in 1993. It was a basicervical fracture, a segmental fracture of middle diaphyseal region, and a Y-shaped fracture of the distal femur. This injury was treated proximally with lag screws,

Fig. 1 A motorbike driver (male, 26 years old) was hit by a car. **a** A vertical basicervical fracture of the left femur (31-B2), together with a transverse middle-third shaft fracture with an interfragment (32-B2). **b** Anteroposterior view. **c** Lateral view of open dislocated fracture of lateral condyle (33-B2) combined with impact medial condyle fracture and an open transverse dislocated fracture of left patella

Fig. 2 Postoperative X-ray of patient from Fig. 1. **a** The neck and shaft fractures of the left femur were treated using a long PFH Medin. The lateral condylar fracture was reduced and fixed using four lag screws. The patellar fracture was treated using a cerclage. **b** The fractures of femoral neck, distal femur and patella healed within five months. The patellar cerclage was removed six months after the injury. **c** The diaphyseal femoral fracture was still not healed 12 months after the accident. Moreover, the distal locking screws of the nail were broken. **d** Because of non-union of the femoral shaft, re-nailing was performed using a reamed femoral nail with dynamic locking

Fig. 3 A 40-year-old man was involved in a motor vehicle accident as a driver. He suffered fractures of both femurs. **a** The right femur had a vertical fracture of the neck (31-B2), an oblique middle-third shaft fracture with an interfragment (32-B2), and a T-shaped fracture of the distal femur (33-C1). The left femur had a stable pertrochanteric fracture (31-A1) and a fragmented wedge fracture of the shaft (32-B3). **b** Ipsilateral fractures of left femur were treated using a long Gamma-nail. The fracture of right neck was treated using a Dynamic Hip

Screw (DHS Synthes). The fixation of diaphysis and distal part of right femur was performed using a 95° blade plate. **c** The left femur healed without complications six months after the trauma. The fracture of the neck of the right femur healed in three months and that of the distal femur healed in six months. A delayed union occurred in shaft fracture, a decortication with cancellous bone grafting was therefore performed six months after the injury

distally by a 95° blade plate and the diaphysis was repaired using a locking nail.

In 1995, Palarčík et al. [10] described a stable pertrochanteric fracture in combination with a transverse diaphyseal fracture and a non-dislocated T-shaped fracture of a distal femur. Here, the pertrochanteric and diaphyseal fractures were stabilised using a reconstruction nail, and the distal fracture was treated using screws that locked the nail at the same time. However, varus deformity of the pertrochanteric fracture occurred during healing, and a second procedure was necessary.

In 2000, Bartoníček et al. [3] described a combination of a stable pertrochanteric fracture with a diaphyseal fracture and a T-shaped fracture of distal femur, together with a fracture of the ipsilateral patella; treatment involved a reconstruction nail and 95° blade plate.

Three cases were published in 2003 by Lambiris et al. [7]. They involved one basicervical and two subtrochanteric femoral fractures. The shaft in each of the cases was broken in the middle third region. The distal fractures were both supracondylar and extra-articular. All patients were treated using reconstruction nails.

The largest number of patients described so far was in 2003 by Barei et al. [2]. It included seven patients ranging in age from 19 to 63 years and the injury mechanism in each case was high-energy trauma. The proximal fracture was either intracapsular (six cases) or a basicervical (one case) fracture of the femoral neck; however, the fracture line was always vertical. Treatment involved cannulated screws in four cases, DHS in two cases, and a reconstruction nail was used in one case. All distal fractures were unicondylar, one affecting the medial condyle and six affecting the lateral condyle. Osteosynthesis was performed on four patients using lag screws, on two patients using a 95° blade plate, and in one case the fracture was left untreated. Treatment of the diaphyseal fractures involved retrograde nailing in four cases, the use of plates in two cases, and a reconstruction nail was used in one case. All fractures healed, and a malunion of the femoral neck fracture was observed in one case.

In summary, 17 cases involving a combination of proximal, distal and diaphyseal femoral fractures have been described in the literature to date. The proximal fractures were intracapsular (7), extracapsular (4), pertrochanteric (4), and subtrochanteric (2). Most of the diaphyseal fractures were located in the middle third of the shaft. The distal fractures were primarily unicondylar, with seven lateral condyle cases and two medial condyle cases. Extra-articular fractures occurred in three patients, one patient had a fissure of the distal femur extending intra-articularly, and four patients had a complete articular fracture. In two cases, a fractured patella complicated the femoral fractures.

All of the authors strongly emphasised an individual approach to the treatment of these injuries [2, 3, 5–7, 10]. It

is appropriate to use no more than two implants. This means that the diaphyseal fracture is stabilised together with either the proximal or distal fracture, using the same implant. The third fracture is then treated with a second implant. The choice of implant is guided by the type of proximal or distal femur fracture. In the area of the proximal femur, femoral neck osteosynthesis can be performed using individual screws, whereas a DHS or an intramedullary hip nail (IMHN) can be used in cases involving a pertrochanteric or subtrochanteric fracture. In a recent paper, Tsai et al. [12] recommend against the use of cannulated screws with antegrade intramedullary nailing in ipsilateral fractures of femoral neck and shaft; they felt that they were associated with a higher incidence of complications.

It is appropriate to use reconstruction nails for osteosynthesis of the proximal femur and femoral shaft, since they can stabilise both fractures very well. Recently, a special locking compression plate (LCP) for the area of the proximal femur has become available.

When treating distal femoral fractures, the type of fracture should be taken into consideration. For the type A fractures, it is reasonable to use retrograde nails, in combination with DHS or cannulated screws for the proximal fracture [2]. It is possible, with certain limitations, to use a reconstruction nail inserted just above the articular surface of the distal femur, so that it stabilises all three levels, although this approach carries a great risk of axial and rotational deviation of the distal fragment [3]. This treatment method was used by Lambiris et al. [7] and resulted in good outcomes. Also Palarčík et al. [10] used a reconstruction nail after reducing the intercondylar fissure using a lag screw. Another possibility is to use a peri-articular plate distally, in combination with a DHS, cannulated screws or IMHN (depending on the fracture type) proximally.

All authors believed that osteosynthesis using cancellous screws is sufficient for stabilisation of type B fractures [3, 7]. We used this technique in two cases with good results. Osteosynthesis with peri-articular LCP can also be used here.

Type C fractures of the distal femur represent the most difficult situation. The treatment depends on the degree of damage to the articular surface of the distal femur. For stabilisation of this type of distal femoral fracture, together with a diaphyseal fracture, we used a 95° blade plate. The same approach was used by Käch [6]. The use of a combination of a reconstruction nail and a 95° blade plate resulted in a valgus deformity. Nowadays, the use of peri-articular LCP is certainly preferable. Apivatthakakul et al. [1] used minimally invasive plate osteosynthesis (MIPO) in the treatment of femoral shaft fractures in patients where intramedullary nailing was contraindicated. Their results were comparable to the results of the femoral shaft treated with intramedullary nailing. Schmal et al. [11] used a

combination of a less invasive stabilisation system (LISS) plate and proximal femoral nails (PFN) for treating ipsilateral proximal and distal femoral fractures. A similar combination can be used with various peri-articular implants for fractures of the middle and distal femur, and a DHS or IMHN for the proximal femur. The results of a biomechanical study [8] suggest that the primary stability provided by these combinations of implants is comparable.

The sequence of fracture treatment remains an important (and still unanswered) question. Barei et al. [2] preferred to begin with the proximal fracture, followed by treatment of the distal fracture, and then concluding with the femoral shaft fracture. However, in their group of patients, all of the distal fractures were type B (i.e. separation of only one of the condyles). Lambiris et al. [7] recommended primary stabilisation of a distal fracture (at least with screws) followed by fixation of the remaining fractures. A similar approach was used by Palarčík et al. [10]; however, they only dealt with an intercondylar fissure. Our approach depends on the type of distal femoral fracture. In the presence of a type B fracture of the distal femur we began with the proximal femur and diaphysis using reconstruction nails and conclude by stabilising the distal fracture with screws. On the other hand, type C fractures are primarily stabilised together with the diaphyseal fracture using a long 95° blade plate. Afterwards the proximal fracture was treated using a DHS.

The aetiology of this pattern of fractures involves frequent, simultaneous injury of the knee joint. In the five cases we reviewed, this was true in three. Lambiris et al. [7] described four patellar injuries and three ligament injuries in 14 cases involving fractures of diaphysis and distal femur; however, they did not mention any knee injury in three patients who had femoral fractures in all three levels. It is essential to treat a patellar fracture as soon as possible; however, it is appropriate to delay final treatment of ligament injuries until after the fracture has healed. In long-term follow-up, four of our patients developed signs of post-traumatic knee arthritis.

Conclusion

Ipsilateral fractures of the diaphysis and both ends of femur are extremely rare injuries, with the diaphyseal trauma dominating the clinical picture. Therefore, it is imperative to deliberately look for signs of fractures to the proximal and distal femur on radiographs, especially when injuries are associated with high-energy trauma. Further, the possibility of a fractured patella and/or proximal tibia and

fibula must also be kept in mind. After stabilisation of the fracture, a thorough examination of a knee is necessary to exclude possible ligament injuries. The order in which the fractures are treated is best left to the discretion of the physician and the circumstances. Apart from general treatment criteria, fracture types of the articular parts of femur have to be taken into consideration. There are several possibilities and the choice is determined not only by the patient's overall condition and types of fractures, but also by the experience and preferences of the surgeon. In our experience, two implants are sufficient for the osteosynthesis, one of them stabilising one end of the femur together with a shaft, while the other implant is used for treating the opposite end of the femur.

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