Arch Orthop Trauma Surg (1991) 110:75–77

Archives of Orthopaedic and Trauma Surgery

Knee ligament injuries combined with ipsilateral tibial and femoral diaphyseal fractures: The "floating knee"

J. J. A. M. van Raay[1], **E. L. F. B. Raaymakers**[1], **and H. W. Dupree**[2]

[1]Department of Surgery, Academical Medical Centre, University of Amsterdam, Meibergdreef 9, NL-1105 AZ Amsterdam, The Netherlands
[2]Department of Surgery, Bleuland Hospital, Bleulandweg 10, NL-2800 BB Gouda, The Netherlands

Summary. The incidence of rupture of the knee ligaments was retrospectively studied in 47 patients with ipsilateral fractures of the femoral and tibial diaphyseal shaft. Fifteen patients proved to have an instability of the knee at the time of follow up. Disruption of the knee ligaments had not been recognised initially. At the time of initial treatment, injury of the knee ligaments had been diagnosed in only three cases. After stabilisation of both fractures in these cases, the knee ligaments had been repaired; at re-examination these patients had no complaints and their knees were perfectly stable. In view of the high incidence of missed cases, the possibility of disruption of the knee ligaments should be considered in all patients with fractures of both the femoral and tibial shaft. Meticulous examination of the knee at the time of injury is strongly advocated.

Ipsilateral fractures of both femur and tibia are not very common but appear to be increasing in frequency. "Floating knee", as this severe injury is known, is mostly seen in polytraumatised patients with injuries of the skull, chest and abdomen as well as multiple fractures of the other extremities [1, 3–5, 7, 8, 10, 14, 15, 17]. Because of this highly complex trauma, knee ligament injury is not always suspected, and therefore the exact icidence of knee ligament rupture is not known. Despite the many different reparative and reconstructive procedures employed by experts in this field, the importance of diagnosing a knee ligament injury in the acute phase is generally recognised [4–6, 14, 15]. Hence, it is vital that damage of the knee ligaments ist not overlooked at first examination of the knee or at physical examination when polytrauma is involved. In order to ascertain the incidence of missed injury of the knee ligaments, a retrospective study was initiated of a series of patients admitted with a floating knee.

Patients and methods

From 1969 to 1988, a total of 55 patients had been treated for ipsilateral fracture of the femoral and tibial shaft. These were mainly polytraumatised patients with associated injuries. The choice of method and timing of treatment of these patients depended on the patients' systemic condition, local soft tissue conditions, and available expertise and implants. When possible, stabilisation of both femoral and tibial shaft fracture was performed as soon as the general condition permitted this. Patients with ipsilateral hip fracture and dislocation, and intra-articular, intertrochanteric and subtrochanteric fractures were excluded, as were those with distal femoral condylar fractures, fracture dislocations of the knee, plateau fractures and tibiofibular fractures.

There were 15 women patients and 40 men. Fourteen patients were less than 20 years old; 15 were 21–30 years old; the remainder were scattered in the decades from 30 years onward. In 48 cases, the fractures were caused by a vehicle or motorcycle accident. Severe skull injury was present in 12 patients, chest and abdominal trauma in 10 patients. Multiple fractures of the other extremities were seen in 24 cases.

Forty-eight of the femoral fractures and 47 of the tibial fractures involved the shaft of the bone. The remainder were in the proximal or distal part of the shaft without involving the hip or knee joint. In 11 patients both fractures were open, with severe soft tissue damage in 8 cases. In 26 patients both fractures were closed. In the remaining limbs (18 patients) either the femoral or the tibial fracture was open. Treatment was started immediately after injury or when the general condition had been stabilised. There were three possibilities for fracture stabilisation: first, rigid fixation of the fractures by plate and screw fixation, intramedullary nailing after reaming or rigid external fixation; secondly, rigid fixation of one of the two fractures; thirdly, treatment of both fractures by conservative methods or non-rigid fixation such as skeletal traction.

Results

In the end, all fractures healed, some after prolonged treatment because of non-union. Most patients had some residual deformity of the extremity or a discrepancy in leg length. In several patients, there was a minor restriction of movement in both hip and knee joint.

In one patient, an arthrodesis of the knee had to be performed because of infection. Another patient suffered severe sepsis caused by *Clostridium welchii* and exarticulation of the hip had to be performed. Naturally, these two patients could not be considered for re-examination. At the time of this study, three patients could not traced, two had died and one refused to participate. This left 47 cases of floating knee available for analysis: 35

Offprint requests to: Dr. E. L. F. B. Raaymakers

Table 1. Methods of fracture stabilisation

	Femur	Tibia
Fixation with plate and screws	28	13
Skeletal traction	10	8
External fixator	2	18
Intramedullary nail	7	0
Plaster	0	8

Table 2. Instability of the knee compared to type of ligament injury

	No. of patients
Rotatory instability	
Anteromedial rotatory instability	7
Combined anterolateral and anteromedial rotatory instability	4
Posterolateral rotatory instability	2
Straight instability (instability in one plane)	
Medial instability	1
Posterior instability	1

men and 12 women. Most fractures were located in the midshaft region of femur and tibia. In six patients both the femoral and the tibial fracture were associated with soft tissue damage. In 19 patients one of the two fractures was open. In the remaining 22 patients there was no evidence of soft tissue damage.

The methods of stabilisation of the femoral and tibial fracture are shown in Table 1. Most femoral fractures were stabilised by rigid internal fixation with a plate and screws. Traction and external fixation was employed in fractures with severe soft tissue damage. External fixation was more frequently used in tibial fractures, both open and closed.

After-treatment varied widely, depending on different factors such as general condition, soft tissue condition, method of stabilisation, and the existence of other fractures.

The follow-up of these 47 patients ranged from 1 to 15 years after the accident. Information concerning the stability of the knee was assessed from the patients' records, and if this was insufficient, the patients were invited for an interview and examination of the knee. Roentgenographic analysis of the knee joint was performed to look for femorotibial arthrosis.

Reliable information about the stability of the knee could be obtained for all 47 patients. In only three had damage to the knee ligaments been diagnosed during the initial hospital stay after rigid fixation of the femoral and tibial shaft fracture. Knee ligament reconstruction by reinsertion of the anterior cruciate ligament and reconstruction of the medial collateral ligament was performed in these patients. At time of follow-up, all three patients were free of complaints and the knee joint showed no residual instability. In 15 cases, there was evidence of knee instability. Follow-up of these patients with damage to the knee ligaments ranged from 13 months to 6 years after trauma. A rotatory instability was found in 13 of these patients while a straight instability was found in 2 (Table 2). Seven of these 15 patients with missed damage to the knee ligaments had complaints at follow-up, varying from non-specific pain to a feeling of giving way. In two cases these complaints went together with moderate swelling of the knee joint. Eight patients with an instability had no complaints at all. Although the majority had regained full strength of the quadriceps and hamstrings at follow-up, many complained that the affected thigh lacked muscular endurence and that it tired easily with any increased activity. Non of the 15 patients either had a history of earlier knee injury or underwent reconstructive surgery for knee instability. No correlation was evident between type of fracture or associated trauma and subsequent ligamentous damage, other than the general finding that the more severe the trauma the greater the likelihood of an associated knee ligament injury. In two patients with missed damage of the knee ligaments, there was evidence of femorotibial arthrosis.

Discussion

Relatively few reports of series of combined tibiofemoral injuries and knee ligament injury have been published. Neither has the combination of a solitary femoral or tibial fracture with injured knee ligaments been frequently reported [2, 9, 11–13, 16, 17]. The mechanism responsible for a combined fracture of the femoral and tibial shaft and knee ligament injury is not clear. There have been doubts whether rupture of the ligaments occurs before failure of the bone. In case of trauma at a site where both a bone and ligament are present, failure of the weakest component, i.e. the ligament, is plausible. Possibly the most common mechanism of damage to the cruciate ligaments and capsule in traffic accidents is when the knees are trapped beneath the dashboard and the trunk is carried up and over the top, hyperextending the knee. If this is coupled with rotation or varus or valgus stress, damage of the collateral ligaments can also result. Fractures of the femoral and tibial shaft are caused by the same mechanism. When the upper portion of the tibia sustains the impact, its posterior displacement on the femur may cause rupture of the posterior cruciate ligament. If the major impact is sustained by the upper portion of the tibia, complete disruption of the knee may result, and there is enough energy left for breaking both the femoral and the tibial shaft afterwards. It is reasonable to assume that the forces causing femoral fracture could also fracture the tibia and disrupt the knee joint.

It seems apparent that the ipsilateral femoral and tibial shaft fracture and knee ligament injury is part of a continuum of combined injuries resulting from complex high-energy forces. There is no clear correlation between the site or type of the fracture and which of the ligaments of the knee is prone to rupture. On the basis of the experience of many authors, a high index of suspicion on knee ligament injury is advisable.

In our series, the incidence of ligamentous laxity of the knee at follow-up was at least five times as high as the incidence of ligamentous rupture diagnosed at the outset. Often, during the physical examination and treatment of a polytraumatised patient, attention is naturally focused on vital functions. If a more careful initial and follow-up examination were conducted, however, the recorded incidence of knee ligament injury would be much higher than it is.

To recognise injury to the ligaments of the knee in patients with ipsilateral fracture of the femur and tibia, one has to suspect the existence of the combined injury. Stabilisation of one or both fractures is usually necessary before the integrity of the ligaments can be accurately tested. When it is impossible to stabilise the femur sufficiently, femoral stability can be achieved by a distal pin, as used in femoral traction. This pin will allow an assistant to control the distal part of the femur and then, having achieved femoral stabilisation, the surgeon is free to manipulate the leg [17].

Physical examination, although a subjective method, can reveal a disruption of the knee ligaments. It is, however, clear that under anaesthesia, since pain and muscle spasm are eliminated, the results of this examination will be more reliable. Additional information can be obtained by diagnostic arthroscopy. Valgus and varus stress radiography or arthrography are of limited value. Ecchymosis and effusion in and around the knee may or may not be present initially but can occur several days after injury. In that case, one must suspect rupture of the knee ligaments. In our series, most of the patients with demonstrable instability were symptomatic, although no patient required reconstructive surgery for instability of the knee joint.

On the treatment of knee ligament injuries, opinions differ widely, but the less favourable results associated with late reconstruction of damaged knee ligaments are generally recognised. In cases of isolated injury to the medial collateral ligament, conservative treatment is preferred to operative reconstruction. Injury to the lateral collateral ligament is usually combined with a ruptured cruciate ligament, and such cases the lateral complex has to be reconstructed. Injury to the anterior cruciate ligament can be treated operatively when a large fragment has been avulsed from the tibia or when the ligament ruptured near its insertion into the tibia or femur. Rupture of the posterior cruciate ligament is often associated with that of the medial collateral ligament and anterior cruciate ligament. Reconstruction is recommended when there is an avulsion out of the tibial plateau.

Surgical repair of the ligament is best accomplished as soon as possible or as early as the general condition of the patient permits such an operation. When rigid fixation of a femoral shaft fracture is not feasible, tibial traction is contraindicated where there is ligament rupture, because this may introduce additional instability [17]. Instead of tibial traction, distal femoral traction can be used.

We found no evidence that knee instability was an overriding determination of functional status. Of the patients with knee instability, 10 of 15 returned to work, all of them to their original occupations, 2 returned to recreational activities and 3 were out of work.

Treatment of this complex injury must address all of the considerations mentioned here and must be individualised for each patient. A more aggressive approach regarding rigid fixation of femoral and tibial shaft fractures might enhance preservation of limb length, prevent malunion, and allow earlier recognition of ligamentous injury to the knee.

References

1. Bansal VP, Singhal V, Mam MK, Gill SS (1984) The floating knee. 40 cases of ipsilateral fracture of the femur and the tibia. Int Orthop 8: 183–187
2. Bertin KC, Marlowe Goble E (1983) Ligament injuries associated with physeal fractures about the knee. Clin Orthop Rel Res 177: 188–195
3. Blake RT, McBryde A (1975) The floating knee. Ipsilateral fractures of the tibia and femur. South Med J 68: 13–164
4. Fraser RD, Hunter GA, Wadell JP (1978) Ipsilateral fracture of the femur and tibia. J Bone Joint Surg [Br] 60: 510–515
5. Grana WA, Gruel J, Wedro B, Hollingsworth S (1984) Complications of ipsilateral femur and tibia fractures. Orthopedics 7: 825–828
6. den Hollander H (1987) Acute kniebandletsels. Thesis, University of Amsterdam
7. Karlstrom G, Olerud S (1977) Ipsilateral fracture of the femur and tibia. J Bone Joint Surg [Am] 59: 240–243
8. Letts M, Vincent N, Gouw G (1986) The "floating knee" in children. J Bone Joint Surg [Br] 68: 442–446
9. Lombardo SJ, Harvey JP (1977) Fractures of the distal femoral epiphyses. Factors influencing prognosis: a review of thirty-four cases. J Bone Joint Surg [Am] 59: 742–751
10. McAndrew MP, Pontarelli W (1988) The long-term follow-up of ipsilateral tibial and femoral diaphyseal fractures. Clin Orthop Rel Res 232: 190–196
11. Moore TM, Patzakis MJ, Paul Harvey J (1988) Ipsilateral diaphyseal femur fractures and knee ligament injuries. Clin Orthop Rel Res 232: 182–189
12. Pedersen HE, Serra JB (1968) Injury to the collateral ligaments of the knee associated with femoral shaft fractures. Clin Orthop Rel Res 60: 119–121
13. Shelton ML, Neer CS, Grantham SA (1971) Occult knee ligament ruptures associated with fractures. J Trauma 11: 853–856
14. Tay BK, Tong GO (1982) Ipsilateral fractures of the femur and tibia. Ann Acad Med 11: 139–141
15. Veith RG, Winquist RA, Hansen ST (1984) Ipsilateral fractures of the femur and tibia. J Bone Joint Surg [Am] 66: 991–1002
16. Walker DM, Kennedy JC (1980) Occult knee ligament injuries associated with femoral shaft fractures. Am J Sports Med 8: 172–174
17. Walling AK, Seradge H, Spiegel PG (1982) Injuries to the knee ligaments with fractures of the femur. J Bone Joint Surg [Am] 64: 1324–1327

Received December 11, 1989