11 femoral fractures with vascular injury

Good outcome with early vascular repair and internal fixation

Martinus Bråten[1], Per Helland[2], Hans O Myhre[3], Anders Mølster[2] and Terje Terjesen[1]

We reviewed 11 consecutive cases with combined femoral fracture and vascular injury presenting with acute ischemia. 6 cases had ischemia exceeding 8 hours and 4 of them developed massive muscle necrosis in the lower leg. 5 cases with ischemia less than 8 hours had no muscle necrosis. Vascular repair preceded fracture stabilization in 5 cases; there were no vascular complications during the subsequent fracture stabilization. 6 fractures treated with internal fixation had uneventful fracture-healing, whereas the 4 which were treated with external fixation needed later reoperations to obtain fracture-healing. We conclude that the limb must be reperfused within 6–8 hours. Vascular repair should be the first procedure, and fracture fixation by internal fixation is then preferred.

Departments of [1]Orthopedics and 3Surgery, University Hospital, Trondheim, Norway and [2]Department of Orthopedics, University Hospital, Bergen, Norway. Correspondence: Dr. Martinus Bråten, Department of Orthopedics, University Hospital of Trondheim, N-7006 Trondheim, Norway. Tel +47 7399-8639. Fax -8722
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Apart from two recent reports (DiChristina et al. 1994, Iannacone et al. 1994), few authors have during the last decade focused on femoral fractures with vascular injury. We reviewed 11 cases with femoral fractures and concomitant vascular injury treated consecutively in two Scandinavian university hospitals during a recent 10-year period. Specifically, we studied the time of ischemia related to muscle necrosis, the choice of method for fracture stabilization and the priority between vascular repair and skeletal stabilization.

Patients and methods

We reviewed the case records and radiographs of all patients with femoral fractures and associated vascular injury treated in the University Hospital of Bergen and University Hospital of Trondheim from 1983 through 1992. Only cases with hard signs of vascular injury (Cone 1989) were considered.

12 patients were treated; all were men. A 77-year-old man with heart disease died in the operating room, mainly because of shock from bleeding. Hence, 11 patients were available for evaluation. Their mean age was 32 (18–57) years.

7 cases were investigated with angiography before the operation, all were done in the angiography suite. 4 were operated on following clinical evaluation alone. In 5 cases, arterial repair was performed before fracture fixation. An autologous saphenous vein graft was used for the vascular repair in all patients except one, who received a PTFE graft (Goretex®). 7 cases had a concomitant venous injury at the same level; all were repaired. No temporary arterial or venous shunts were used.

6 fractures were treated with internal fixation (4 intramedullary nails, 2 angled plates), 4 with external fixation (Hoffmann fixator in 2 cases, Orthofix fixator in 2), and case 7 had no operative fracture fixation.

Lower leg fasciotomy was performed in all cases, except case 9. We planned to open all 4 compartments. However, decompression was incomplete in case 1, and a reoperation was performed after 2 days.

Results

Vascular injury

All 5 patients where arterial repair was performed within 8 hours recovered without clinical signs of ischemic injury of the extremity. 6 patients had ischemia exceeding 8 hours; 3 of them were later amputated (Table 1). Case 2 had a thigh amputation; cases 3 and 6 had knee disarticulations. Case 1 developed massive necrosis in the calf muscles, but amputation was avoided.

5 cases had vessel repair preceding fracture stabilization. No vascular complication occurred during or after the subsequent fracture repair in these limbs.

Table 1. Ischemia and muscle necrosis

Case	Hours of ischemia	Muscle necrosis/ amputation
1	28	+
3 [a]	20	+
11	15	–
2 [a]	14	+
6 [a]	13	+
8	12	–
7	8	–
9	8	–
10	8	–
4	6	–
5	4	–

[a] Cases 2, 3 and 6 underwent amputation.

Skeletal injury

All 6 fractures treated by internal fixation had an uneventful fracture healing. The 4 patients treated with external fixation all underwent secondary procedures for various reasons. Case 5 was converted to locked nailing after 2 months because the Hoffmann frame provided insufficient stability. Case 9 suffered a refracture few days after removal of the fixator (Figure 1), and in case 10 a pseudarthrosis developed after treatment with an Orthofix fixator (Figure 2). Furthermore, in case 2 adequate stability was never achieved with the Hoffmann fixation. An above-knee amputation became necessary after 3 months due to unstable fracture fixation, osteomyelitis and massive muscle damage in the lower leg.

A minimally displaced intercondylar fracture was immobilized in a dorsal plaster cast. The fracture dislocated, but internal fixation was precluded because of wound infection in the fasciotomy incisions. The fracture healed with an incongruent and painful patellar joint (case 7).

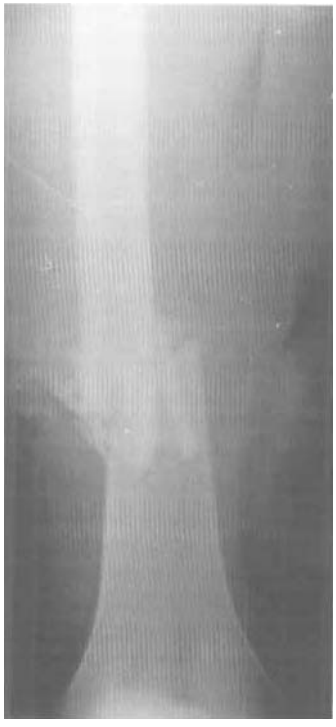
Discussion

Striated muscle does not tolerate warm ischemia for more than 4–8 hours (Miller and Welch 1947). An amputation rate of 86% has been reported when ischemia exceeds 8 hours in popliteal artery injuries (Green and Allen 1977). The individual ischemia tolerance is difficult to predict because of variations in collateral blood flow. This is of particular interest in the femoral region, where blood flow can follow different pathways.

Figure 1. Case 9.

Case 9 stabilized with Orthofix fixator after vascular repair. Refracture after 3 months. Final stabilization with angled plate.

Figure 2. Case 10.



Bilateral open and comminuted femoral fracture, ischemia on both sides.

Left side healed after 6 months, pseudarthrosis on right side.

Pseudarthrosis treated with nail.

A satisfactory collateral circulation can explain why 2 patients (cases 8 and 11) with ischemia of 12 and 15 hours' duration, respectively, avoided muscle necrosis. All limbs where the circulation was restored within 6–8 hours did not develop ischemic injury. This is in keeping with previous reports (Howard and Makin 1990, Schlickewei et al. 1992). We therefore conclude that every attempt should be made to restore arterial blood flow within 6–8 hours.

The choice of fracture stabilization in complex skeletal and vascular injuries is controversial. While external fixation is recommended in open battlefield injuries (Rich et al. 1971), both internal and external fixation are used in a civilian context (Alexander et al. 1991, Schlickewei et al. 1992).

Locked intramedullary (IM) nailing of the femur gives good fracture-healing and a low rate of local complications (Christie et al. 1988, Böstman et al. 1989, Alho et al. 1991). Recent reports show that primary IM nailing is a safe method in open fractures of the femur (O'Brien et al. 1991, Grosse et al. 1993). In combined injuries, the main objection to IM nailing is that it is too time-consuming if performed before vascular repair. If carried out after vascular repair, it has been argued that the subsequent nailing procedure can jeopardize the vascular anastomosis (Barros D'Sa 1989).

The same objections apply to plate osteosynthesis which, compared to IM nailing, causes more healing and infection problems (Böstman et al. 1989).

External fixation is an attractive alternative in combined injuries because of the rapid application and minor soft-tissue involvement. Despite the healing problems we encountered after external fixation, our material is too limited to claim that external fixation is an inferior method in the treatment of femoral fractures. But it illustrates that the choice of fracture fixation should be planned thoroughly. Our experience indicates that internal fixation, preferably IM nailing, should be used whenever possible.

The priority between skeletal stabilization and vascular repair has been much debated. Some authors prefer to perform stabilization first (Nunley et al. 1981, Barros D'Sa 1989), whereas others prefer to do the vascular repair first (Ashworth et al. 1988, Cone 1989). There are obvious advantages with primary fracture fixation: a vessel graft of optimal length can be fashioned and an undisturbed vessel repair can

take place. The penalty, however, could be a prolonged ischemia time. Vascular repair as the first procedure will reduce the ischemia period. It seems that a properly performed vascular anastomosis can withstand the forces caused by the fracture stabilization (Bongard et al. 1989, Alexander et al. 1991), which is in accordance with our experience.

Our material shows that two requirements must be met in the management of femoral fractures combined with arterial injury. The first and most important is that the limb must be reperfused within 6–8 hours. Secondly, fracture fixation should be optimal to reduce complications related to the skeletal part of the injury. These demands can raise a management dilemma. The solution might be to use temporary vascular shunts (Johansen et al. 1982, Barros D'Sa 1989). A shunt provides an almost immediate restoration of blood flow, which allows an optimal fracture-repair to take place without increasing the ischemia period.

Regarding the diagnostic procedures, we agree that angiography in the angiography suite should be avoided, because it will usually delay the treatment (Howard and Makin 1990, Alexander et al. 1991). The patients should be transferred to the operation theater immediately to save time, and angiography should be limited to cases where the level of vascular injury is uncertain or where there is uncertainty whether a vessel is actually injured. Arteriograms obtained in the operation theater are of adequate quality in trauma situations (Cone et al. 1989).

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