External fixation of distal femoral fractures in adults’ multcentre retrospective study of 43 patients

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ARTICLE INFO

Article history:
Accepted 7 July 2014

Keywords:
External fixator
Open femoral fracture
Distal femoral fracture

ABSTRACT

Background: A multicenter cohort of 43 adults with distal femoral fractures (DFFs) managed with external fixation was evaluated to determine the potential of this treatment.

Patients and methods: The patients were young adults (mean age: 39.6 years) with high-energy trauma; 12 had polytrauma and 41 multiple fractures. Most patients (38/43) had compound DFFs. Fracture types were A in 3 patients, B in 3 patients, and C in 37 patients. A tibio-femoral construct was required in 11 patients and a femoro-femoral construct in 32 patients.

Results: The normal femoral axis was restored within 5° in the coronal plane in 34 (79%) patients and in the sagittal plane in 22 (51%) patients. Axis restoration within 5° in both planes was achieved in 19 (44.7%) patients. After femoro-femoral external fixation, mean malalignment was 4.2° in the coronal plane and 8.6° in the sagittal plane; corresponding values after tibio-femoral external fixation were 1.3° and 8.6°. In 23 patients (of whom 1 was lost to follow-up), external fixation was intended as the only and definitive treatment; among them, 1 required amputation after a failed revascularization procedure, 10 achieved fracture healing within a mean of 21.2 weeks, 6 required conversion to another technique, and 5 underwent non-conservative procedures (total knee arthroplasty in 3 and arthrodesis in 2). In the remaining 20 patients, conversion to internal fixation was intended initially and performed within a mean of 4.7 weeks; 1 of these patients required amputation for ischemia, 3 did not achieve fracture healing, 12 achieved primary fracture healing, and 4 achieved fracture healing after repeated grafting (n = 3) or osteotomy (n = 1). At last follow-up (at least 1 year), the mean International Knee Society (IKS) Function Score was 67.3 and an IKS Knee Score of 68.5. Range of active flexion was 85.7° overall, 62.3° in the group with intended definitive external fixation and 101° in the group with intended conversion to internal fixation. Healing without complications was achieved in 10 (43%) in the former group and 12 (60%) in the latter group.

Conclusion: Our data support provisional external fixation followed by early conversion to internal fixation in patients with extensively compounded DFFs; patients with multiple fractures requiring several surgical procedures; and polytrauma patients awaiting hemodynamic, respiratory, or neurological stabilization.

Level of evidence: IV, retrospective study.

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1. Introduction

Fractures of the distal femoral metaphysis and epiphysis raise major therapeutic challenges that are met by direct internal fixation using modern screw-plates with locking screws or
retrograde intra-medullary nailing [1]. External fixation (EF) of these fractures has been evaluated in a small number of studies after the first case-series were published [2,3] and is usually reserved for extensively compounded fractures and/or fractures with ischemia [4–8] (Table 1). Rather than technical difficulties in implanting the fixation device, the limited use of EF is chiefly ascribable to the unreliability of the anatomic reduction, (most notably at the knee joint); risk of infection developing from the pins; and risk of knee stiffness due to fixation through the quadriceps muscle. The current management of patients with polytrauma involving provision stabilization, known as damage control, followed by internal fixation is generating new interest in EF [9,10,11,12], particularly as improvements have been achieved regarding the technical practicability and the reliability of EF devices. In this paradigm, emergency EF is secondarily converted to internal fixation when allowed by the patient’s general condition and/or when all the technical requirements are met.

Here, we report a retrospective evaluation of a multicenter cohort of patients with DFFs managed by EF. Our primary objective was to evaluate the clinical and radiological outcomes and to define the role for EF among the various available femoral-fixation methods.

2. Material and method

For the 2013 SoFCOT symposium1, 12 centers recruited patients with DFFs as defined by Müller et al. [13]. Patients were included prospectively in 2012, and patients managed between 2000 and 2011 were evaluated retrospectively. Of 899 included patients, 43 (5%) were managed using EF (see supplementary data).

There were 32 males and 11 females with a mean age of 39.6 years (range: 16–77 years) (supplementary data). Co-morbidities with a potential for affecting the outcome were present in 9 patients (alcohol abuse and smoking, n = 6; psychiatric disease, n = 2; and substance abuse, n = 3). The mechanism of the injury was a vehicle accident in 31 patients, a fall in 7 patients including 5 who fell from elevated heights, a gunshot wound in 3 patients, and a crush injury in 2 patients. All but 2 patients had multiple fractures; 20 patients had another fracture in the same lower limb (tibial fracture, n = 10; patellar fracture, n = 8; and femoral shaft fracture, n = 2). The remaining 21 patients had variable combination of fractures. Polytrauma was present in 12 patients.

In the Gustilo classification [14], 38 fractures were compound and there were 12 type I, 10 type II, and 18 type III (10 III A, 3 III B, and 5 III C). Common fibular nerve palsy was noted at presentation in 1 patient and complete sciatic nerve palsy in another. In the Müller AO fracture classification [13], the distribution was type A, n = 3; type B, n = 3; and type C, n = 37. Two metaphyseal fractures had cylindrical cortical defects measuring several centimeters.

Surgery was performed within a mean of 4.8 hours (range: 2–16), using a tibia-femoral construct in 11 patients and a femoro-femoral construct in 32 patients. In 23 patients, the epiphyseal fractures were reduced and fixed by screws or pins during the same procedure. Placement of the EF device was followed in 4 patients by a vascular repair procedure; another patient, who had popliteal artery dissection, did not undergo vascular surgery. Skin wounds were managed using simple suturing in 32 patients, negative-pressure dressings in 5 patients, and a local flap in 1 patient. Intensive care unit admission was required in 20 patients, who had a mean stay length in the unit of 14.7 days (maximum: 60 days).

3. Results

3.1. Early anatomic outcomes

Immediately after surgery, the femoral axis in the coronal plane was measured in 38 patients and was within 5° of normal in 30 (79%); the remaining 8 patients had deviations of 5° to 10°. In the sagittal plane, 39 patients with measurements, 20 (51%) had an axis within 5° of normal, 16 had deviations of 5° to 10°, and 3 had deviations greater than 10°. The femoral axis was within 5° of normal in both planes in 17 (44.7%) patients.

Epiphyseal reduction was considered anatomic in 34 (83%) of the 41 patients with available information. Mean axis deviations were 4.2° in the coronal plane and 8.6° in the sagittal plane in the group managed with femoro-femoral EF; corresponding values in the group managed with tibio-femoral EF were 1.3° and 8.6°.

3.2. Categorical outcomes

We identified two groups a posteriori based on whether EF was initially intended as the only and definitive fixation method (defEF group) or as a bridge to internal fixation (brEF group) (Fig. 1).

The defEF group had 23 patients. Among them, I required amputation after thrombosis of a vascular bypass and another recently underwent removal of the EF device equipped with an extension rail to manage a circumferential metaphyseal bone defect (Fig. 2). One patient was lost to follow-up. In 10 patients, the EF device was used for a mean of 21.2 weeks (range: 8–47 weeks) and ensured fracture healing within a mean of 17.1 weeks (range: 6–42 weeks); 3 patients received autologous bone grafts and 1 manipulation under anesthesia. Surgical site infection occurred in 3 of these 10 patients and responded to appropriate antibiotic therapy. The reduction was inadequate in 3 patients who underwent secondary conversion to internal fixation. In 4 patients, non-union, with infection in 2 cases, occurred and was successfully managed using plate fixation and autologous bone grafting. In addition, 3 patients with inadequate reduction and non-union underwent revision surgery with either total knee arthroplasty (n = 1) or arthrodesis (n = 2). Finally, 1 patient with a B3.1 fracture and torn posterior cruciate ligament underwent total knee arthroplasty after failed ligament reconstruction.

In the 20 patients in the brEF group, conversion to internal fixation was performed after a mean of 4.7 weeks (range: 1–16 weeks). In 1 of these patients, plate fixation was followed by irreversible

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1 Presented during the symposium on the management of displaced supra-, inter- and uni-condylar fractures of the distal femur at the 88th annual SoFCOT meeting held in Paris in November 2013.

Table 1
Main retrospective studies of external fixation for distal femoral fractures.

<table>
<thead>
<tr>
<th>Author</th>
<th>n</th>
<th>Compound Fracture</th>
<th>Ischemia</th>
<th>Primary healing</th>
<th>Mean knee flexion (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hutson [6]</td>
<td>16</td>
<td>12</td>
<td>1</td>
<td>14/16</td>
<td>92</td>
</tr>
<tr>
<td>Bonneville [7]</td>
<td>26</td>
<td>16</td>
<td>5</td>
<td>24/26</td>
<td>90</td>
</tr>
</tbody>
</table>

External fixation was the only treatment used in the first two studies, whereas in the remaining two studies conversion to internal fixation was performed in 12/26 and 16/16 patients, respectively.
Fig. 1. Distribution and outcomes of the 43 patients depending on the treatment planned initially: defEF Group external fixation only; or brEF group external fixation followed by conversion to internal fixation.

EF, external fixation; TKA, total knee arthroplasty

Fig. 2. Courtesy of Bertin, MD, Nîmes. (A) Gustilo IIIc fracture due to a gunshot wound with sciatic nerve palsy. (B) Femoro-femoral extension rail after infra-trochanteric corticotomy. (C) Final radiological results. Weight bearing with protection by an orthosis. Active knee motion: 0°–20°.
ischemia requiring amputation at the thigh. Fracture healing was achieved within a mean of 26.8 weeks (range: 10–96 weeks) in 12 patients managed with plate fixation (n = 9), nailing (n = 2), or screw fixation (n = 1); autologous bone grafting was performed during the conversion procedure in 3 patients (Fig. 3). Surgical site infection developed in 2 of these patients and was treated successfully with antibiotics alone. A patient with a gunshot wound and a metaphyseal-epiphyseal defect was managed with provisional femoro-femoral EF combined with a cement spacer to prepare for secondary arthroplasty. Septic non-union developed in 4 patients, who achieved fracture healing after 40, 56, 82, and 70 weeks (with arthrodesis in 1 patient), respectively; of the 2 patients with aseptic non-union, 1 achieved fracture healing after internal fixation with bone grafting and the other was managed with total knee arthroplasty.

3.3. Final outcomes

The clinical and radiological outcomes were evaluated after at least 1 year, and mean follow-up was 2.8 years. Patients with amputation (n = 2), arthrodesis (n = 3), or total knee arthroplasty (n = 4) were excluded, leaving 34 patients for the evaluation of final outcomes. International Knee Society (IKS) scores were determined in only 23 of these patients: the mean IKS function score was 68.5, and the mean IKS knee score was 67.3. Mean range of active flexion (n = 30) was 85.7°. Table 2 reports the clinical outcomes in the defEF and brEF groups.

3.3.1. Follow-up and amputation

In 2 patients, amputation was required due to malalignment of the knee and severe pain, respectively. In 3 patients, arthrodesis was performed (2 with transarticular and 1 with screw and plate fixation). In 4 patients, total knee arthroplasty was performed. The mean follow-up for these patients was 2.8 years.

3.3.2. Clinical outcomes

Table 2 Categorical results for the overall population, the group with external fixation initially planned as the definitive treatment, and the group with external fixation initially planned as a bridge to internal fixation patients who required amputation, arthrodesis, or total knee arthroplasty were excluded.

<table>
<thead>
<tr>
<th>Group</th>
<th>IKS knee score</th>
<th>IKS function score</th>
<th>Active flexion (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall (n = 34)</td>
<td>68.5</td>
<td>67.3</td>
<td>85.75</td>
</tr>
<tr>
<td>EF as definitive treatment (n = 10)</td>
<td>71.4</td>
<td>62.7</td>
<td>62.3</td>
</tr>
<tr>
<td>EF as bridge to IF (n = 13)</td>
<td>64</td>
<td>70.9</td>
<td>101</td>
</tr>
</tbody>
</table>

IKS: International Knee Society; EF: external fixation; IF: internal fixation.
In 26 patients, the mean deviation in the coronal plane was 3° and the maximum deviation was 18° of varus; 20 patients had less than 5° of deviation. In the sagittal plane (n = 26), the mean deviation was 2.9° and the maximum deviation was 30° of recurvatum; 24 patients had less than 5° of deviation. Mean leg-length inequality (n = 24) was 6 mm with a maximum value of 40 mm; 15 patients recovered the normal femoral length. In 13 patients, the femoral axis was within 5° of normal in both the coronal and sagittal planes and leg length was within 5 mm of the contralateral side.

Primary fracture healing without major complications was achieved in 10 (43%) patients in the defEF group and in 12 (60%) patients in the brEF group.

4. Discussion

EF was the least often used fixation method in the cohort established for the 2013 SoFCOT symposium. EF was used in specific situations, in compliance with published data [4–8,11,12,15,16]. Our results should be interpreted with care given the retrospective multicenter design. In addition, the follow-up was too short for an assessment of possible progressive joint lesions. Finally, the groups were too small to allow a statistical analysis.

Non-conservative options were used in some patients to handle problems that developed over time. They consisted in arthrodesis for septic non-union in 3 patients and arthroplasty in 4 patients. The setting largely explains the severity of the complications and only fair outcomes. Many factors, often present in combination, explain the risk of infection over time: 88% (38/43) of patients had compound fractures, of which nearly two-thirds were Gustilo stage III, 56% (24/43) had concomitant skin lesions, 28% (12/43) had polytrauma, and 46.5% (20/43) required intensive care unit admission. The non-union rate was 30%. The initial treatment was successful in achieving primary healing in 43% of patients in the defEF group and 60% in the brEF group. The performance of EF in terms of mechanical outcomes and reduction remains only fair. The large muscle masses keep the connecting bar at a distance from the mechanical axis, and placement of the device parallel to the mechanical axis is challenging. In addition, considerable time is often required to assemble the device because of fracture extension into the femoral shaft and of fracture-site comminution. The pins are subjected to high stresses that induce micro-motion, with a resulting decrease in initial construct stability. Our cohort was too small and heterogeneous to allow a comparison of femoro-femoral and tibio-femoral constructs. Results in terms of active knee flexion were only fair, despite the use of manipulation under anesthesia and/or arthrolysis: active flexion was 62.3° in the defEF group and 101° in the brEF group, in keeping with previously published data (Table 1). Many factors, of which some are not specific of EF, can lead to knee stiffness: they include polytrauma with intensive care unit admission and multiple fractures with several sites at different levels of the same lower limb. The main difference between the defEF and brEF groups was for active flexion, with a nearly 40° gain after brEF compared to defEF, whereas the IK5 scores were similar (Table 2). These data support early conversion of EF to internal fixation [17–19].

Thus, the indications of EF are limited to distal femoral lesions that have specific characteristics and/or that result from high-energy trauma responsible for extensive compounding or vascular injuries. Extensively compounded Gustilo IIIB and C fractures constitute the indication of choice for EF. During management of the skin wound, the epiphyseal fracture site may be readily stabilized by simple screw fixation, and the EF then serves only to provide overall stability to the fracture site. In a patient with life-threatening polytrauma or multiple fractures, EF provides provisional stability, thereby allowing nursing care and facilitating life-supporting interventions and the control of visceral and/or cranio-cerebral injuries. Conversion to internal fixation should be performed early, with removal of the EF device during the surgical approach to the fracture site and fixation using a plate or nail. Beyond the 3rd week and/or in patients with active infection, a period of traction is recommended between EF device removal and internal fixation to allow preparation of the skin entry sites and pins that might be contaminated.

Disclosure of interest

L.B, G.P, E.V, and R.B declare that they have no conflicts of interest concerning this article. P.B is an educational consultant for Depuy, Stryker, and Amplitude. ME is an educational consultant for Depuy-Synthes.

Acknowledgements

We are grateful to the other symposium participants who made this study possible: C. Hulet, T. Brunet (Caen), L. Pidhorz (Le Mans), C. Chantelot, G. Dumont (Lille), J.C. Bel, J.C. Cogan (Lyon), X. Flecher, M. Lebaron (Marseille); C. Court, M. Soubeyrand (Paris, Bicêtre), F. Dujardin, S. Rahali (Rouen), G. Ducrot (Strasbourg).

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.otsr.2014.07.024.

References


