A 10 cm Traumatic Femoral Defect Treated with a Transport Technique Followed by a Lengthening Procedure. Sequential Use of a Monotube External Fixator and an Intramedullary Rod

Daniel Schlatterer*
Orthopaedic Trauma, Atlanta Medical Center, Atlanta, GA, USA

Abstract

This case report details the management of a 10 cm femoral defect. A 56-year-old female sustained bilateral open femur fractures after her parachute malfunctioned. Initial treatment included an emergent debridement and irrigation and temporary external fixation. A subtrochanteric femoral osteotomy was performed on postinjury day 6. Femoral transport proceeded for 2 months, during which time the traumatic femoral defect healed spontaneously. The retrograde femoral nail was locked, and the monotube was subsequently removed. The patient started independent ambulation and began noting her leg to be short 2–3 cm. Despite accommodative shoe inserts, she developed low back and hip and knee pain. She elected for a femoral lengthening procedure, which entailed lengthening over a new nail and a new external fixator. This required 4 months and ended with removal of the second external fixator and locking the second femoral rod. This patient is now 3 years since injury and reports minimal back and leg pain and nearly equal leg lengths.

1 Brief Clinical History

This healthy 56-year-old female sustained bilateral open femur fractures after her parachute malfunctioned (Fig. 1a, b). No neurovascular injuries were noted. The right femur was grossly contaminated with grass and gravel and mud up into her femoral canal. This femur required use of an oscillating saw to adequately debride it (Fig. 2). Treatment stages for the right femur included emergent debridement and irrigation, temporary external fixation, transport procedure initiated 6 days after injury, transport for 2 months, removal of monotube and locking of the femoral nail, and then a lengthening procedure 5 months after transport completion (18 months after injury). During the transport phase, the traumatic femoral defect healed spontaneously after only 4 cm of transport of the proximal femur distally into the defect (Fig. 5a–c). This resulted in a much shorter than anticipated transport time. The patient started independent ambulation and began noting her leg to be short 2–3 cm. Despite accommodative shoe inserts, she developed low back and hip and knee pain. She elected for a femoral lengthening procedure, which required 4 months and ended with removal of the second external fixator and locking the femoral rod. This patient is now 3 years since injury and reports minimal back and leg pain and nearly equal leg lengths (Fig. 8a, b).

2 Preoperative Clinical Photos and Radiographs

See Figs. 1 and 2.

*Email: danschlatterer@yahoo.com
Fig. 1  (a) Antero-posterior (AP) radiograph of the right femur on day of injury. (b) Lateral radiograph of the right femur on day of injury

Fig. 2  Radiograph after debridement with oscillating saw and external fixation application
3 Preoperative Problem List

1. Grossly contaminated right open femur fracture.
2. Distal femoral fracture with intercondylar extension.
3. Segmental femoral bone loss measuring 10 cm.
4. Residual leg length inequality of 3 cm.

4 Treatment Strategy

The treatment strategy began with an aggressive debridement to minimize infection risk. Once the soft tissues had stabilized, the surgical options to treat the femoral defect were considered. A significant segment of femur was missing distally, so a transverse subtrochanteric osteotomy was planned (Fig. 3a). The proximal femoral segment would then be transported by external fixation over a femoral nail. On hospital day number 6, an osteotomy was performed, and a monotube external fixator and a retrograde femoral nail were placed (Fig. 3a–c). The surgical plan was to transport the proximal femur into the distal defect (Fig. 4a, b). After 2 months of transport, the distal defect spontaneously healed, and no further transport was required (Fig. 5a–c). The femoral cortices were reconstituted, continuous and tolerant of full weight-bearing. The patient noticed several
months later that her leg was short 3 cm. She requested a lengthening procedure, which required 4 months to complete.

5 Basic Principles

Emergent debridement of the open fractures and external fixation were the initial and primary principles followed to minimize infection risk. Six days later, the soft tissues were deemed suitable for a transport procedure. The transverse subtrochanteric femoral osteotomy was completed in a stepwise fashion with drill bits and osteotomes to minimize bone necrosis. Distraction was initiated 10 days after the osteotomy. It was continued at a rate of 1 mm/day. The lengthening procedure performed 5 months after transport completion (18 months after injury) followed the same osteotomy principles and principles of internal and external fixation. The combination of external fixation to transport and lengthen over a rod permitted removal of the external fixator before complete consolidation of the regenerate (less time with external fixation), decreased risk of fracture, and early rehabilitation (Paley et al. 1997).

6 Images During Treatment

See Figs. 3, 4, and 5.
Femoral lengthening can be complicated by varus angulation. When the osteotomy and lengthening approach the distal femur, the leg can become subluxed posteriorly. These two potential issues were countered with use of a rod for guidance of the monorail, and at the time of the lengthening procedure, the tensor fascia lata was “Z” lengthened near the knee to limit posterior subluxation. It is important to check in the operating room that distraction and lengthening will occur over the femoral rod. In the second stage of treatment for this patient, the osteotomy site gapped intraoperatively as we distracted the monotube. We failed to notice before leaving the operating room, however, that the femoral rod was not sliding distally with the distal femoral segment (Fig. 7). This titanium rod had been in place for 18 months and became adherent to the canal. Over the next several weeks, the monotube was lengthened, but no movement at the osteotomy site was noted. A return trip to the operating room included removing the old nail, reaming the canal, and placing a smaller-diameter rod. The system progressed as planned thereafter. Figure 5a–c is a clinical photo showing the monotube and pins under considerable load during the transport, and this repeated itself but for a different reason during lengthening. Use of a rod has been reported to decrease refracture

7 Technical Pearls

Femoral lengthening can be complicated by varus angulation. When the osteotomy and lengthening approach the distal femur, the leg can become subluxed posteriorly. These two potential issues were countered with use of a rod for guidance of the monorail, and at the time of the lengthening procedure, the tensor fascia lata was “Z” lengthened near the knee to limit posterior subluxation. It is important to check in the operating room that distraction and lengthening will occur over the femoral rod. In the second stage of treatment for this patient, the osteotomy site gapped intraoperatively as we distracted the monotube. We failed to notice before leaving the operating room, however, that the femoral rod was not sliding distally with the distal femoral segment (Fig. 7). This titanium rod had been in place for 18 months and became adherent to the canal. Over the next several weeks, the monotube was lengthened, but no movement at the osteotomy site was noted. A return trip to the operating room included removing the old nail, reaming the canal, and placing a smaller-diameter rod. The system progressed as planned thereafter. Figure 5a–c is a clinical photo showing the monotube and pins under considerable load during the transport, and this repeated itself but for a different reason during lengthening. Use of a rod has been reported to decrease refracture
Fig. 6 (a) Radiograph 5 months after osteotomy for femoral transport demonstrating healed traumatic defect. (b) Lateral radiograph corresponding to (a)

Fig. 7 Intra-operative fluoroscopy demonstrating second osteotomy. The osteotomy was tested for completeness, however it was not noted at this surgical setting that the rod was non-mobile
rate and earlier rehabilitation (Paley et al. 1997). In this particular case, the rod permitted removal of the external fixator monotube system months before complete femoral consolidation.

8 Outcome Clinical Photos and Radiographs

See Figs. 6, 7, and 8.

9 Avoiding and Managing Problems

Please see case numbers 192 and 194 for additional discussion points regarding femoral lengthening problems. In this particular case, two adverse events occurred. First, pin site problems occur more often and to a greater extent with transport techniques. The pins are moving through the soft tissue planes and not moving the entire bony and soft tissue segment together (Fig. 3b). This was anticipated, and the patient was informed to expect this complication. At the time of removal of the monotube after transport, the entire compromised soft tissue envelope was excised and a layered closure completed. The other issue, which was not expected, was the binding of the titanium femoral nail (Fig. 7). We tested the external fixator in the operating room and noticed gapping at the osteotomy site, but we did not check to see if the nail moved in any fashion (Fig. 7). We should have noticed the proximal end of the nail near the subtrochanteric region to be moving further distal as we tested the distraction mechanism of the monotube. We were able to complete the second osteotomy around the retrograde femoral nail, but in the many months that passed since it was first placed, it became bound to the medullary canal. In the future, a nail exchange will be part of the preoperative plan.
10 Cross-References

▶ A 12 cm Traumatic Femoral Defect Treated with a Long Oblique Diaphyseal Femoral Osteotomy and Lengthening Over a Nail

References and Suggested Reading