Case 9: Limb Salvage After Massive Traumatic Femoral Bone Loss

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Abstract

The initial decision of whether to pursue limb salvage or primary amputation depends on the state of nerves, vessels, and soft tissue. The treatment protocol in damage control consists of debridement and irrigation, vascular repair, fracture repair, and temporary skin coverage. Associated massive bone loss remains a challenge for the treating surgeon. The Ilizarov method of distraction osteogenesis with bone transport has successfully treated large segmental bone defects. However, treatment is usually long and adverse events are not uncommon. There are technical pearls that may diminish these problems and they are revealed in this case.

1 Brief Clinical History

A 17 year old male was injured in a motorcycle accident. The polytraumatized patient sustained a subtotal traumatic amputation of the distal femur with 26 cm (10.24 in.) bone defect and a dislocation of the left hip. The patient was primarily treated according to the principles of damage control.

2 Preoperative Clinical Photos and Radiographs

See Figs. 1 and 2.

3 Preoperative Problem List

1. Polytraumatized patient
2. Left hip dislocation
3. Type 3 open femoral fracture (subtotal amputation)

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Fig. 1 Clinical picture of the bone defect

Fig. 2 Three-dimensional CT reconstruction of the leg. Contrast agent was utilized for detecting a vascular injury

4. Massive bone defect with absent patellar tendon
5. Vascular injury (femoral vein laceration)
6. Contaminated soft tissue

4 Treatment Strategy

(a) Closed reduction of the hip dislocation.
(b) Mounting of a joint-bridging external fixator.
(c) Vascular repair of the femoral vein.
(d) Fasciotomy of the upper and lower leg and temporary coverage with synthetic skin.
(e) Custom-made spacer with bone cement and K-wires was placed into the bone gap (07/2010).

During the following weeks,

(f) Several revision surgeries and changing of the Vacuum assisted closure (VAC) was performed until
(g) Split-skin graft covered the soft tissue defect (08/2010).

The leg length discrepancy was treated by:

(h) Mounting a monotube on the femur
(i) A multiplanar ring fixator on the tibia. Osteotomies were performed just below the lesser trochanter and below the tibial plateau.
(j) A Hoffman fixator was added to connect the two frames in the knee region (09/2010).

In the last step,

(k) An arthrodesis nail was inserted after frame removal to reduce the consolidation time in the frame and to realign all fragments (05/2011).

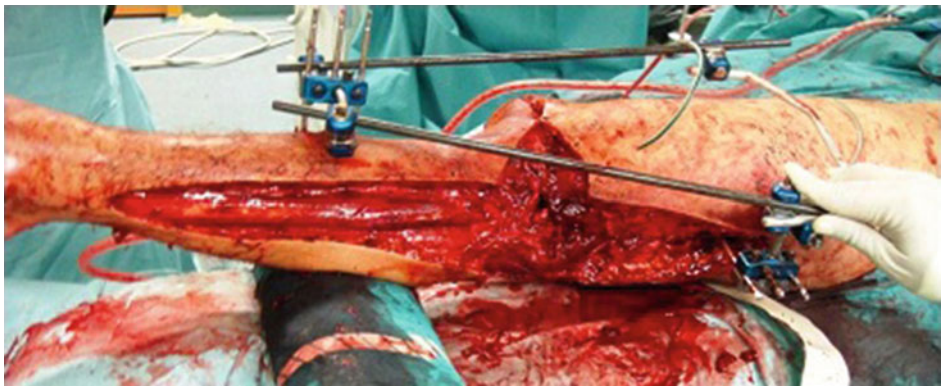

Fig. 3 Intra-operative picture with a joint-bridging external fixator and a large soft tissue defect and after performing a fasciotomy on the lower limb – initial treatment

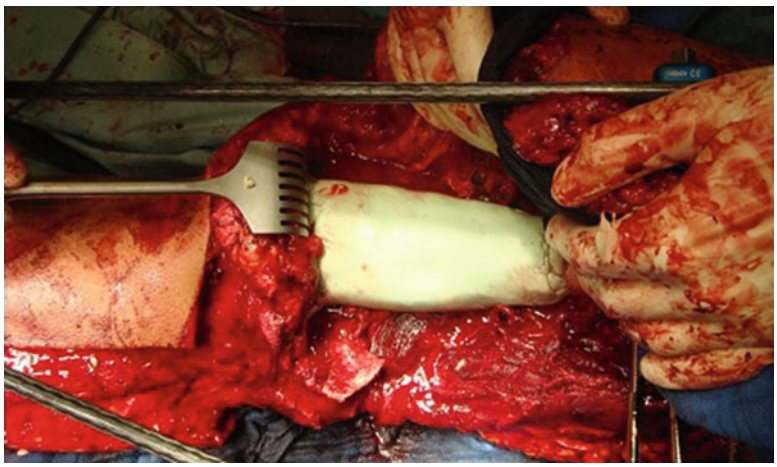

Fig. 4 The bone defect is filled with a custom-made cement spacer, supported by wires and external fixator

Fig. 5 Anterior and lateral view showing the left knee joint with the cement spacer

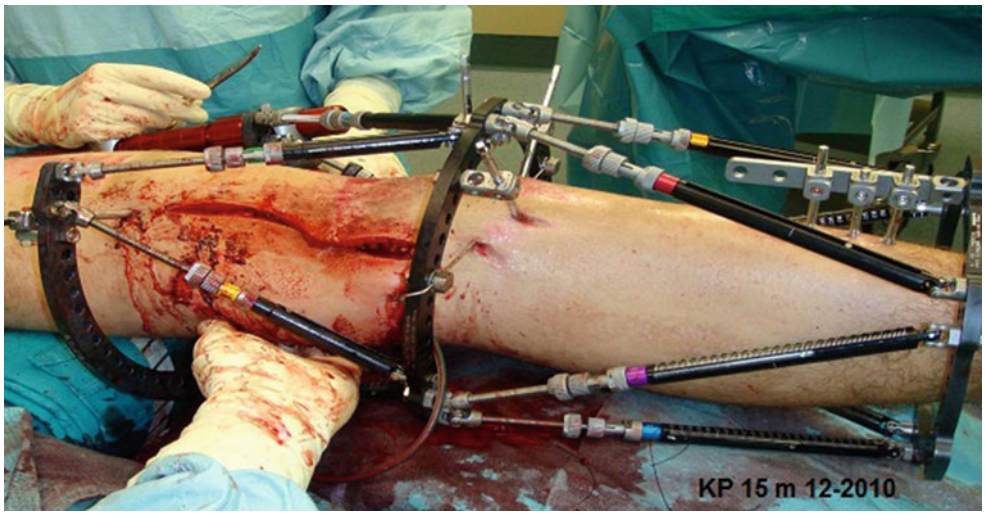

Fig. 6 Intra-operative picture of the ring fixator, taken during a revision surgery

Fig. 7 Long-leg standing X-rays with frame mounting during bifocal distraction

5 Basic Principles

1. Anatomic joint reconstruction in cases of severe or destroyed articular fractures is usually not possible in the initial damage control surgery. In these cases a **joint-bridging external fixator** is useful to protect the soft tissue, to stabilize the joint when severe ligament injury is present, or when a vascular repair has been performed.
2. **Vessel injuries** commonly occur in multiple-injured patients especially in the lower extremity. Direct injuries are caused by sharp and stump violence, indirect mechanisms by tension, distraction, or torsion. The diagnosis or suspicion of a vascular injury begins with the clinical investigation. Hard signs include active hemorrhage, large expanding or pulsatile hematoma, absent palpable pulses distally, and distal ischemia.
3. Early **surgical soft tissue debridement** must be performed to promote healing by secondary intention. All visible dirt and (non-penetrating) foreign bodies have to be removed. A bacteriological smear should be taken before disinfection. The wound environment should be cleaned with brushes and disinfection fluid – layer by layer. Irrigation is performed with high volume of saline solution.
4. The Ilizarov technique has become the gold standard for treatment of segmental tibial and femoral bone defects and lengthening. Depending on the kind and dimension

Fig. 8 X-ray of the arthrodesis nail in a.p. and lateral view

of bone loss, bone segment transport is the therapy of choice for larger defects, while distraction after optional compression is used for smaller lesions. After osteotomy, a fracture hematoma appears in the osteotomy gap, which has osteogenetic potency for new bone formation. By distracting two bony fragments (called callus distraction) or by shifting a bony part to another (called **segment transport**), callus formation is induced. Segment transport is therefore performed over an external ring fixator by daily moving a bony segment, fixed on a wire or a pin connected to the frame, to bridge the bone defect.

6 Images During Treatment

See Figs. 3, 4, 5, 6, and 7.

7 Technical Pearls

The technical pearls in this case were the primary large soft tissue and the massive bone defect on the lower limb.

1. To handle the massive 26 cm bone defect at the distal femur, a customized **wire and cement spacer** was constructed to bridge the gap, and furthermore the limb was shortened 15 cm. Hereby multiple 2 mm K-wires were interposed between the bone ends and coated with Refobacin-Palacos bone cement providing basic stability. The spacer avoids soft tissue collapse into the defect, prevents adherence of free flaps with the surrounding musculature, creates a soft tissue tunnel for later reconstruction, and maintains the soft tissue anatomy.

Fig. 9 Clinical picture of the patient while taking the long-leg standing X-ray

Fig. 10 X-ray of the arthrodesis nail in a.p. view 4 years after trauma showing bony union

Fig. 11 Lateral X-ray of the knee 4 years after trauma showing bony union

2. The prolonged treatment in an external frame over months and years is associated with several complications and is stressful for the patient and the treating orthopedic surgeon. Although osteodistraction performed according the Ilizarov's principles remains a reliable method, fractures and complications at the docking site are frequently reported. Furthermore bending of the new bone regenerate in long bone defects is often noticed. Therefore the concept of **nailing after lengthening (NAL)** with primary external fixation and limb lengthening followed by internal stabilization with nail or plate has been established to achieve definitive limb reconstruction.

8 Outcome Clinical Photos and Radiographs

See Figs. 8, 9, 10, 11, and 12.

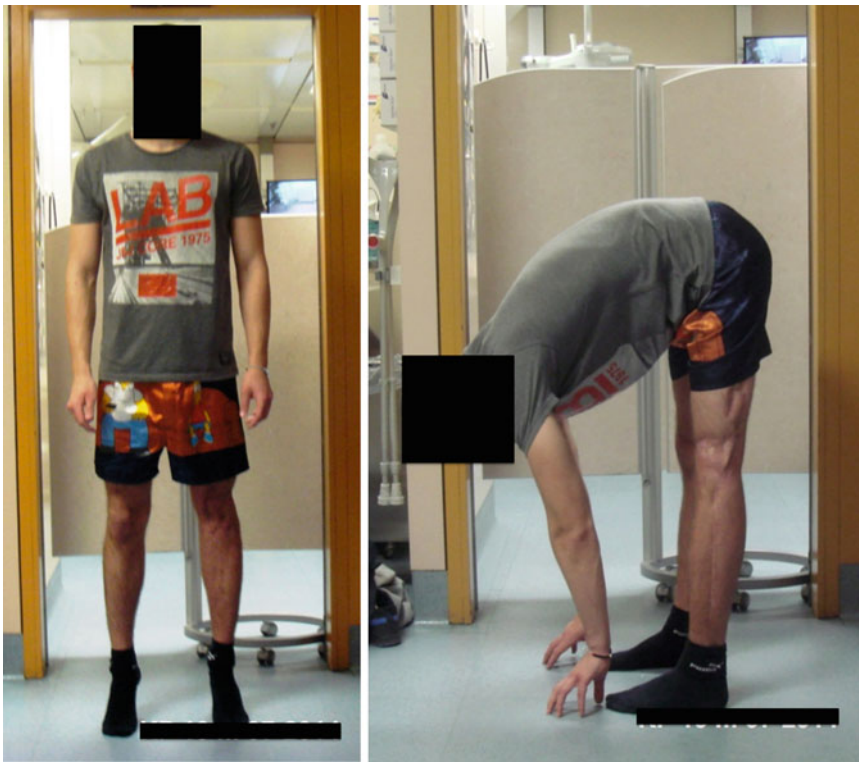

Fig. 12 Clinical picture of the patient 4 years after trauma

9 Avoiding and Managing Problems

For initial decision-making between limb salvage and primary amputation, different lower-extremity injury-severity scoring systems and guidelines were published. However, none of these scores can replace the experience of the orthopedic surgeon. None of these scores include the individuality of each single case. Absolute indications for amputation are Gustilo type IIIC fractures associated with nerve injuries.

10 Cross-References

- Case 16: Acute Shortening and Then Lengthening
- Case 26: Plating After Lengthening
- Case 38: Impaired Joint Motion During and After Callus Distraction

References and Suggested Reading

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