Orthopaedics & Traumatology: Surgery & Research 102 (2016) 131–134

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

Case report

Three-step sequential management for knee arthroplasty after severe ballistic injury: Two cases

Y. Herry[a], F. Boucher[b,d], P. Neyret[a,d], T. Ferry[c,d], S. Lustig[a,d,*]

[a] Centre Albert-Trillat, CHU Lyon Croix-Rousse, hospices civils de Lyon, 69004 Lyon, France
[b] Service de chirurgie plastique, CHU Lyon Croix-Rousse, hospices civils de Lyon, 69004 Lyon, France
[c] Service de maladie infectieuse, CHU Lyon Croix-Rousse, hospices civils de Lyon, 69004 Lyon, France
[d] Centre de référence des infections ostéo-articulaires complexes Rhône Alpes Auvergne, hospices civils de Lyon, 69004 Lyon, France

ARTICLE INFO

Article history:
Received 11 May 2015
Accepted 25 August 2015

Keywords:
Gunshot traumatism
Ballistics
Arthroplasty
Knee

ABSTRACT

Management of knee bone loss after gunshot trauma requires a multidisciplinary approach. Two cases of knee arthroplasty after devastating ballistic trauma are reported. Treatment comprised several steps: sampling, bone resection, reinforced cement spacer, latent sepsis control, and prosthetic reconstruction. The patients showed no neurovascular disorder and had a functioning extensor mechanism. At follow-up of at least 2 years, results were satisfactory, with return to unaided walking and mean International Knee Society (IKS) score improved from 18 to 59 points. In light of these observations, knee reconstruction arthroplasty using a sequential strategy can provide satisfactory functional outcome after severe ballistic trauma.

1. Introduction

Treatment strategy for severe ballistic trauma to the knee is not described in the literature. We have drawn up a management protocol for this situation in which severe joint destruction [1] requires surgical reconstruction [2].

A 3-step surgical strategy is implemented after the acute phase.

Step I comprises hardware removal and sampling. Step 2 comprises septic surgery, with bone cuts and positioning a reinforced cement antibiotic-laden spacer, as widely practiced in implant revision surgery [3,4]. Step 3 is arthroplasty, performed after an interval of time, when infection control has been achieved. Contraindications to arthroplasty comprise neurovascular disorder and extensor system tear [5]. Risk of sepsis is high [6,7], and requires bacteriological analysis, with at least 6 weeks' adapted antibiotherapy before considering implantation. The 3-step strategy was drawn up due to this major risk of infection. A second bone cut step limits risk of sepsis at implantation, delayed until samples prove sterile or antibiotherapy adapted to bacteriological findings has been initiated.

We report two cases of knee arthroplasty using the above protocol following severely destructive ballistic trauma.

2. Case reports

2.1. Patient no. 1

A 58 year-old man had a hunting accident in 2009 involving low-energy ballistic trauma [8], with Cauchoix III open fracture of the distal right femur.

Initial examination found no neurovascular lesions. Emergency lavage and wound care was performed, with osteosynthesis by external fixator; the bone defect was filled with cement. Revision surgery was needed for infection at 3 months (Fig. 1).

Complete assessment was conducted before considering reconstruction surgery: MRI to check extensor system integrity, and CT-angiography to check the vascular axes. The external fixator was removed 9 months post-trauma and samples were taken (Step 1). Step 2 was implemented 6 weeks later, with bone cuts in healthy tissue (9 cm femoral and 1 cm tibial resection using a dedicated cut guide) and insertion of a nonreinforced antibiotic-laden cement spacer. Postoperative course featured thrombopenia induced by heparin, with superior vena cava and left common femoral vein thrombosis, which resolved completely. The patient was reoperated at 2 months for fracture of the spacer, which was replaced by a reinforced model (Fig. 2).

A rotating hinge reconstruction prosthesis (RHK, OSS™, Biomet®) was finally implanted in November 2010, with probabilistic antibiotic-laden cement (Step 3: Fig. 3; Table 1).

* Corresponding author. Centre Albert-Trillat, CHU Lyon Croix-Rousse, hospices civils de Lyon, 69004 Lyon, France.
E-mail address: sebastien.lustig@chu-lyon.fr (S. Lustig).

http://dx.doi.org/10.1016/j.otsr.2015.08.014
1877-0568/

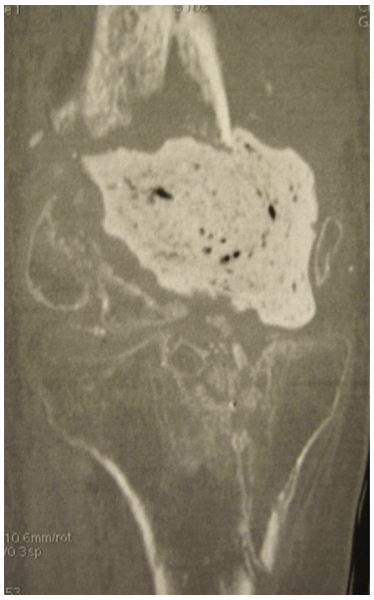

Fig. 1. CT scan: complex fracture of femur and tibia, major bone defect, cement spacer.

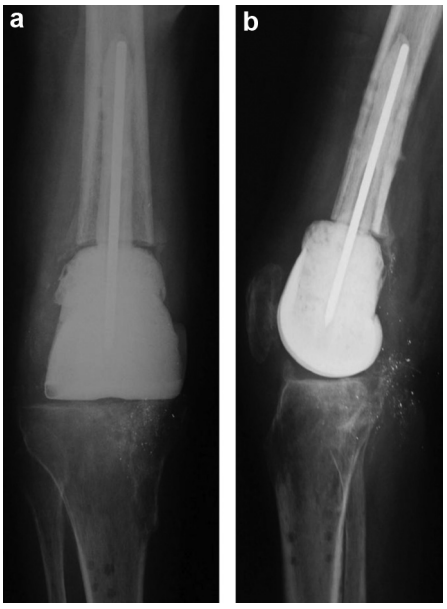

Fig. 2. a, b: AP and lateral X-ray: reinforced cement spacer to maintain limb length.

At 5 years' follow-up, the patient could walk without canes, with 2 cm compensation for lower-limb length discrepancy. Range of motion was 0–0–100°. International Knee Society (IKS) score was 74.

2.2. Patient no. 2

A 62 year-old male sustained a hunting accident in 2012, with Cauchoix III open fracture of the proximal left tibia.

Initial work-up found no sensorimotor or vascular disorder. Emergency management comprised lavage and wound care, with osteosynthesis by external fixator and 4 screws. Negative pressure therapy was initiated due to loss of cutaneous substance on the posteromedial exit side (Fig. 4).

Bone cover was achieved by medial gastrocnemius muscle transfer.

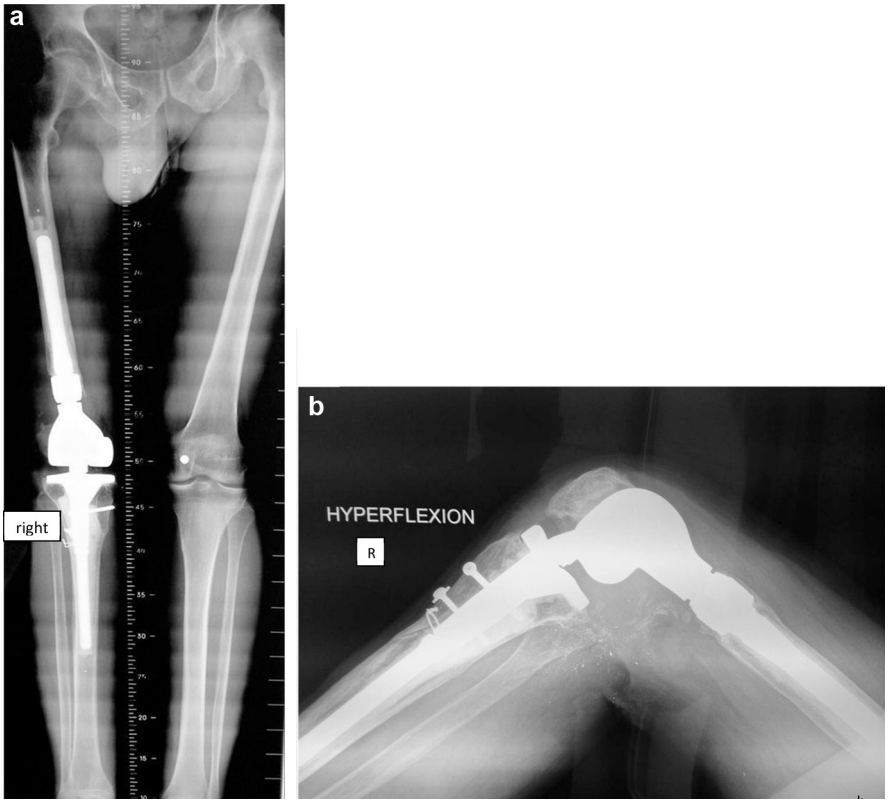

Fig. 3. a, b: AP and lateral whole-knee X-ray in maximal flexion at 5-year follow-up.

Table 1
Patient no. 1, samples and antibiotherapy.

	Samples	Antibiotherapy
Aug. 18, 2009: trauma		Ceftriaxone gentamicin
Sept. 1, 2009: effusion on pins	*Escherichia coli*	Ceftriaxone ofloxacin
Feb. 1, 2010: external fixator ablation	Sterile	
March 1, 2010: septic surgery	*Staphylococcus epidermidis, Staphylococcus warneri, Bacillus spp*	Ceftriaxone teicoplanin ofloxacin vancomycin fosfomycin rocephin Teicoplanin
May 1, 2010: revision for spacer fracture	Sterile	Teicoplanin
Nov. 26, 2010: reimplantation	Sterile after therapeutic window	Teicoplanin then cessation

Imaging assessment on CT and MRI found extensor system continuity despite anterior tibial tuberosity fracture, and no neurovascular lesions (Fig. 5).

Reconstruction was initiated at 6 months, with external fixator removal, excision of bone sequester, and sampling (Step 1). Step 2 comprised of septic bone cut in the proximal extremity of the tibia and insertion of an antibiotic-laden reinforced cement spacer, conserving the extensor system by raising the tibial tuberosity (Fig. 6). The patient developed jugular and left subclavian vein thrombosis, which resolved completely under anticoagulation therapy.

Arthroplasty using a rotating hinge reconstruction prosthesis (RHK, OSS™, Biomet®) was performed in 2013, with 3 cm resection of the distal femur (Step 3). Table 2 shows bacteriology findings and antibiotherapy. Postoperative course was simple. At 24 months' follow-up, the patient could walk without canes, with 3 cm compensation. Range of motion was 0–0–35. IKS score was 44 (Fig. 7).

3. Discussion

The main objective of total knee replacement in ballistic trauma is to restore function. Bone loss secondary to the trauma and septic resection indicates multi-step surgery with constrained implants [9]. Results with these prostheses are generally good [10], with recovery of unaided walking and complete extension.

Fig. 4. a, b: preoperative X-rays.

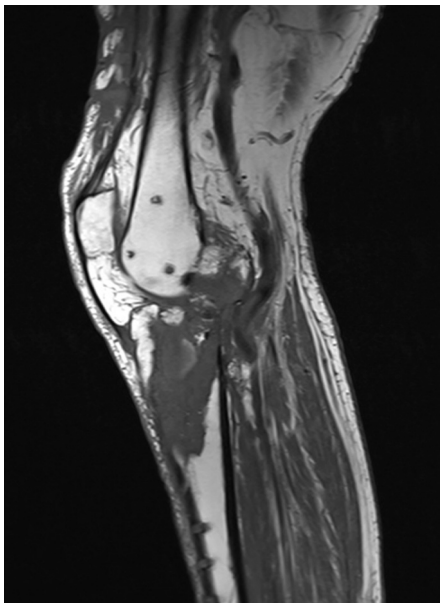

Fig. 5. MRI: extensor mechanism continuity.

Fig. 6. a, b: X-rays with cement spacer.

Table 2
Patient no. 2, samples and antibiotherapy.

	Samples	Antibiotherapy
Dec. 15, 2012: trauma	*Staphylococcus aureus, Enterococcus*	Ceftriaxone vancomycin ofloxacin
May 27, 2013: external fixator ablation	Sterile after therapeutic window	Ceftriaxone vancomycin
June 17, 2013: septic surgery	Sterile after therapeutic window	Ceftriaxone vancomycin
Sept. 9, 2013: reimplantation	*Staphylococcus epidermidis* after therapeutic window	Vancomycin sulfamethoxazole trimethoprim then daptomycin then linezolid

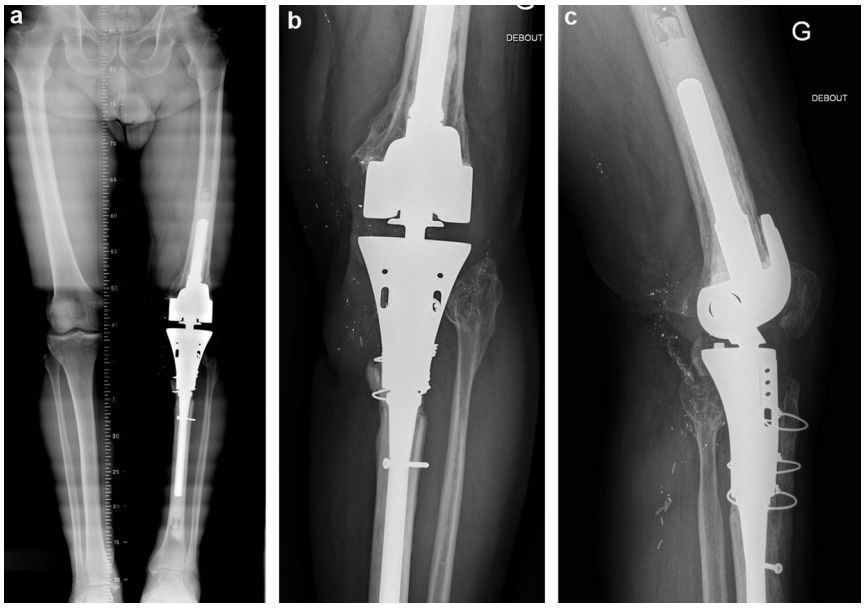

Fig. 7. X-rays at FU with rotating hinge prosthesis.

In devastating ballistic trauma, ranges of motion remain less than with similar first-line or revision implants in a nonseptic context [11].

Management of ballistic trauma should be multidisciplinary. Medically, sepsis is inevitable and requires teamwork with infectologists. Knee replacement should be performed only after bacteriologic analysis and effective antibiotherapy of sufficient duration [12]. Surgically, skill in plastic surgery (negative pressure, flap, etc.) is mandatory [13]).

Morbidity nevertheless is elevated [10], with serious complications found in both patients. Prolonged antibiotherapy may prove toxic in such cases, which should be taken into account in primary decision-making.

In conclusion, total knee replacement in devastating ballistic trauma can restore satisfactory function despite restricted flexion, but requires multi-step management and entails a high rate of complications. Multidisciplinary management is essential.

Disclosure of interest

P. Neyret: royalties from Tornier, research and institutional support from Tornier; S. Lustig: research and institutional support from Tornier. The other authors declare that they have no competing interest.

References

[1] Dougherty PJ, Vaidya R, Silverton CD, Bartlett C, Najibi S. Joint and long-bone gunshot injuries. J Bone Joint Surg Am 2009;91:980–97.
[2] Calori GM, Colombo M, Malagoli E, Mazzola S, Bucci M, Mazza E. Megaprosthesis in post-traumatic and periprosthetic large bone defects: issues to consider. Injury 2014;45(Suppl. 6):S105–10.
[3] Classen T, von Knoch M, Wernsmann M, Landgraeber S, Loer F, Jager M. Functional interest of an articulating spacer in two-stage infected total knee arthroplasty revision. Orthop Traumatol Surg Res 2014;100:409–12.
[4] Nickinson RS, Board TN, Gambhir AK, Porter ML, Kay PR. Two stage revision knee arthroplasty for infection with massive bone loss. A technique to achieve spacer stability. Knee 2012;19:24–7.
[5] Biau D, Faure F, Katsahian S, Jeanrot C, Tomeno B, Anract P. Survival of total knee replacement with a megaprosthesis after bone tumor resection. J Bone Joint Surg Am 2006;88:1285–93.
[6] Bae DK, Yoon KH, Kim HS, Song SJ. Total knee arthroplasty in stiff knees after previous infection. J Bone Joint Surg Br 2005;87:333–6.
[7] Suzuki G, Saito S, Ishii T, Motojima S, Tokuhashi Y, Ryu J. Previous fracture surgery is a major risk factor of infection after total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2011;19:2040–4.
[8] Seng VS, Masquelet AC. Management of civilian ballistic fractures. Orthop Traumatol Surg Res 2013;99:953–8.
[9] Morgan H, Battista V, Leopold SS. Constraint in primary total knee arthroplasty. J Am Acad Orthop Surg 2005;13:515–24.
[10] Holl S, Schlomberg A, Gosheger G, Dieckmann R, Streitbuerger A, Schulz D, et al. Distal femur and proximal tibia replacement with megaprosthesis in revision knee arthroplasty: a limb-saving procedure. Knee Surg Sports Traumatol Arthrosc 2012;20:2513–8.
[11] Calori GM, Colombo M, Ripamonti C, Malagoli E, Mazza E, Fadigati P, et al. Megaprosthesis in large bone defects: opportunity or chimaera? Injury 2014;45:388–93.
[12] Bernard L, Legout L, Zurcher-Pfund L, Stern R, Rohner P, Peter R, et al. Six weeks of antibiotic treatment is sufficient following surgery for septic arthroplasty. J Infect 2010;61:125–32.
[13] Hou Z, Irgit K, Strohecker KA, Matzko ME, Wingert NC, DeSantis JG, et al. Delayed flap reconstruction with vacuum-assisted closure management of the open IIIB tibial fracture. J Trauma 2011;71:1705–8.