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Case Report

Segmental bone defect of the femur: a clinical case of reconstruction with an osteoseptocutaneous fibular free flap with allograft

Gonçalo S. Fernandes[1]*, Catarina Corte-Real[1], João C. Mendes[1], Ricardo C. Dias[1], João Pires[1], Emanuel Homem[2], João Boavida[1], António P. Lopes[1]

[1]Department of Orthopaedics, ULS Coimbra, Coimbra, Portugal
[2]Pediatric Orthopedics Department, Hospital Pediátrico, ULS Coimbra, Coimbra, Portugal

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***Correspondence:**
Dr. Gonçalo S. Fernandes,
E-mail: goncalo74@gmail.com

ABSTRACT

Segmental bone defects (SBD) of the distal femur present complex challenges in orthopedic surgery with various reconstruction methods available, such as fibular flaps. We present a case of a SBD of the distal femur reconstructed with an osteoseptocutaneous fibular free flap with allograft, as described by Capanna. A 25-year-old man suffered a Gustillo-Anderson-IIIA supraintercondylar fracture AO/OTA C2.3 with an SBD of the distal femur from a motorcycle accident. Initial treatment included closed reduction, internal fixation with percutaneous screws and osteotaxis. Subsequently, he underwent minimally invasive osteosynthesis. Reconstruction at 17 days post-injury involved a contralateral vascularized osteoseptocutaneous fibular free flap with allograft using the Capanna technique. The patient was allowed free range of motion, achieving 95º by 6 weeks postoperatively, and 120º by 7 months. Partial weight-bearing was allowed at 3 months postoperatively, progressing to full weight-bearing at 5 months. Radiographic graft integration was found at the 18 month re-evaluation. At 4 years the graft is integrated, and no complications were reported. SBDs of the femur pose a challenging entity. Among the various described reconstruction techniques, notable ones include arthroplasties, induced membrane technique (Masquelet), bone transport, allografts/autografts, and flaps. The use of the described technique increases integration rates despite donor site morbidity. Early percutaneous reduction and fixation of the distal femur articular component reduced the complexity of the subsequent procedure. The technique described by Capanna allows for reconstruction with structural support, possibly reducing the risk of non-union and fracture, and represents a valid alternative in SBDs >6 cm.

Keywords: Segmental bone defect, Fracture, Reconstruction, Capanna, Fibular flap, Allograft

INTRODUCTION

Segmental bone defects of the distal femur present complex challenges in orthopedic surgery with various reconstruction methods available, such as fibular flaps, especially for >6 cm defects.[1-3]

We present a case of a segmental bone defect of the distal femur reconstructed with an osteoseptocutaneous fibular free flap with allograft, as described by Capanna.[4,5]

CASE REPORT

A 25-year-old man suffered a Gustillo-Anderson IIIA supra-intercondylar fracture AO/OTA C2.3, with SBD of the distal femur from a motorcycle accident. The bone fragment was delivered, contaminated, 2 h after admission.

Initial treatment included closed reduction and internal fixation with percutaneous screws and osteotaxis. 12 days post-injury he was submitted to the removal of the

osteotaxis and to a minimally invasive osteosynthesis with a distal femur LCP plate.

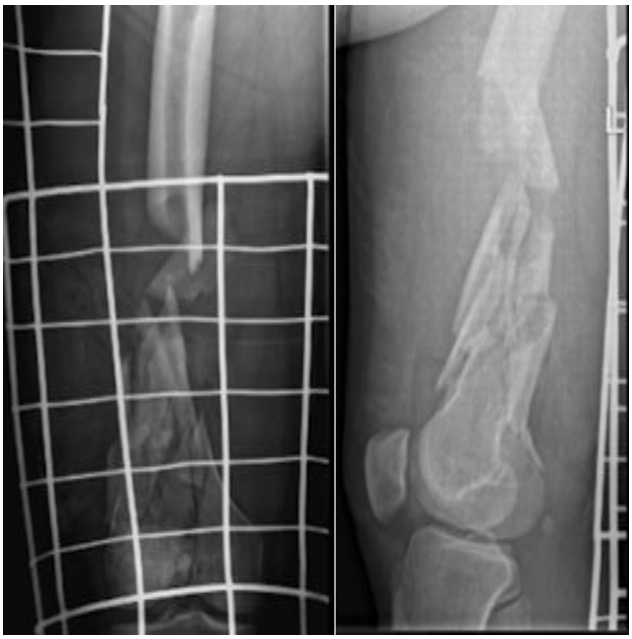

Figure 1: Distal femoral fracture AO/OTA C2.3, Gustilo-Anderson IIIA.

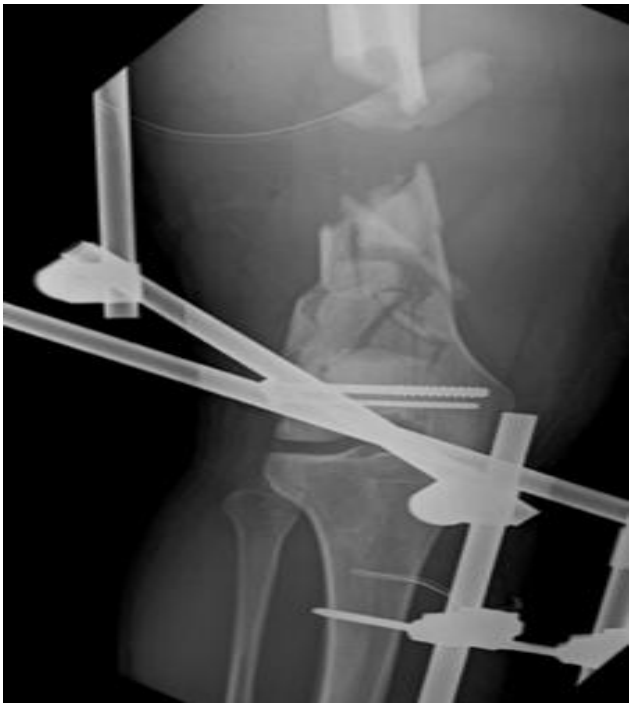

Figure 2: Femoral osteotaxis and percutaneous osteosynthesis in the emergency operating room

Reconstruction at 17 days post-injury involved a contralateral vascularized osteoseptocutaneous fibular free flap with allograft using the Capanna technique in collaboration with the plastic surgery team, with 2 simultaneous surgical teams to minimize the graft's ischemia time and the surgery length. At 18 days post-op, complications arose with pedicle venous thrombosis.[4,5]

Figure 3: Bone fragment.

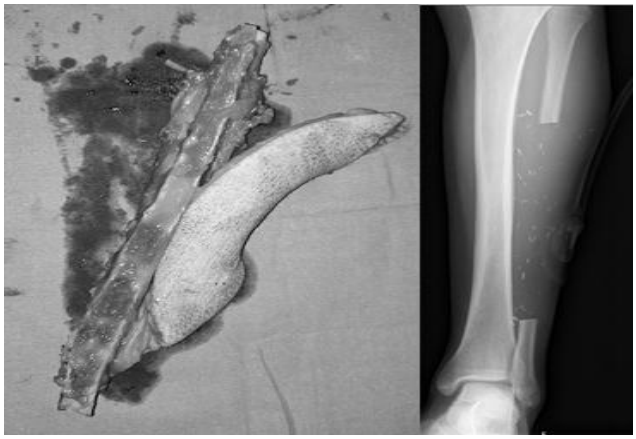

Figure 4: Fibula graft and donor site.

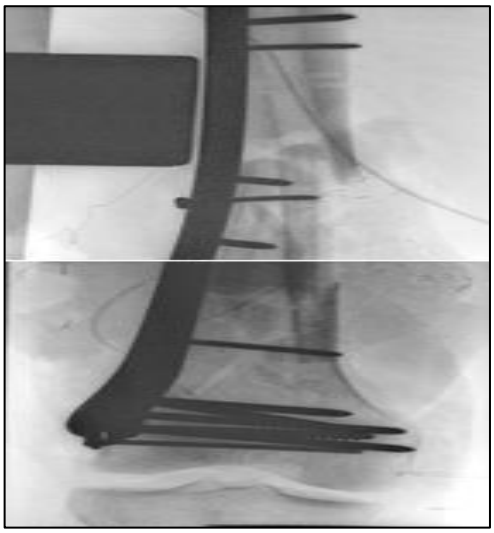

Figure 5: Intraoperative radiograph after reconstruction.

The patient was allowed free range of motion and concomitant physiotherapy, achieving 95º by 6 weeks postoperatively, and 120º by 7 months. Partial weight bearing was allowed at 3 months postoperatively, progressing to full weight-bearing at 5 months.

There were no radiographic signs of graft integration at 7 months. Graft integration, defined as uninterrupted external bony borders between the graft and recipient bone on orthogonal radiographs, was found at the 18-month re-evaluation, as well as 120° active-range-of-motion (AROM) and a VAS score of 0.

At 4 years the graft is integrated, and no complications were reported.

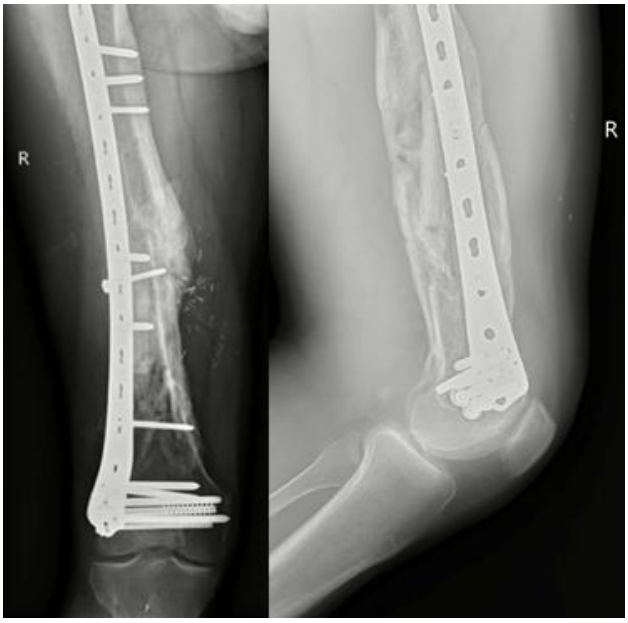

Figure 6: Femoral reconstruction at 18 months.

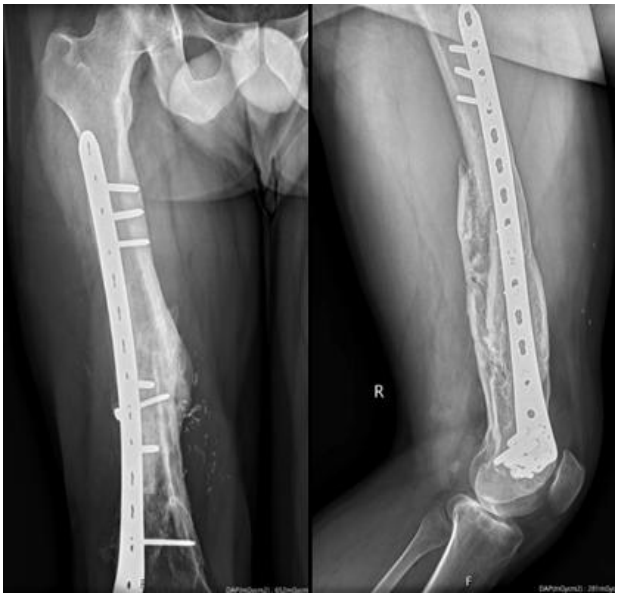

Figure 7: Femoral reconstruction at 4 years.

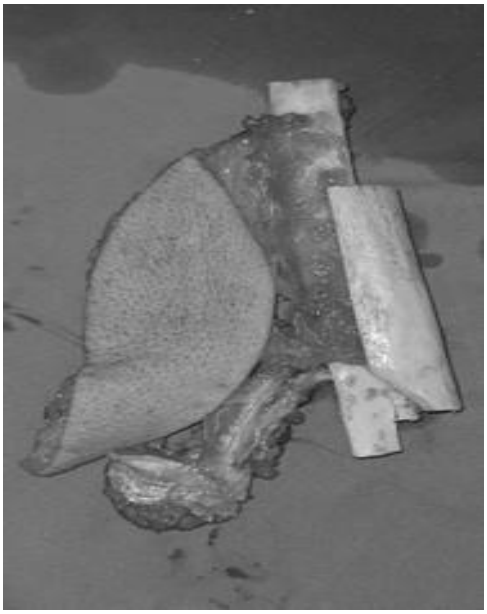

Figure 8: Osteoseptocutaneous fibular free flap with allograft.

DISCUSSION

SBD are challenging, particularly in the context of an open fracture. Open fractures have a progressive infection rate correlated with the Gustilo-Anderson classification, with infection rates of up to 5-10% for IIIA fractures, reaching 13.8% in the FLOW and PREP-IT trials.[6,7] These fractures often need an initial temporary treatment with external fixators, for which the best timing for conversion from external fixation to internal fixation is still controversial.[6] Nowotarski et al suggested that external fixators can be directly replaced by internal fixation within 1 to 2 weeks, without an increased infection rate.[6,8]

For the definitive treatment, several reconstruction techniques exist, such as arthroplasty, induced membrane technique (Masquelet), bone transport, reamer irrigator aspirator (RIA), allografts, autografts and flaps.[9-12] Biological reconstruction was preferred for this patient. To achieve this goal, the reconstruction needed to provide osteogenic cells, osteoconductive scaffolds, growth factors and a stable mechanical environment proposed by Giannoudis et al as the diamond concept for fracture healing.[13]

A fibular free flap reconstruction offers bone integration potential with osteogenesis, osteoconduction and osteoinduction capabilities, but it offers little structural support due to femoral mismatch and entails potential donor site morbidity and vascular complications. Conversely, allograft reconstruction provides good structural support with long-term fracture risk, but no osteogenesis potential, while avoiding donor site morbidity. The combination of an allograft and free fibular flap provides structural support, bone integration and erases the disadvantages of each individual technique.[1,3]

The patient was submitted to a staged approach, with debridement, early percutaneous fixation of the distal femur articular component with concomitant fracture stabilization with external fixators, and a delayed femoral reconstruction using a contralateral vascularized osteoseptocutaneous fibular free flap with allograft. The patient achieved 120º AROM by 2.7 months, likely due to the early articular fracture reduction with percutaneous screws. Osteointegration was achieved by 18 months. This result contrasts to an osteointegration time of the fibula flaps of 8.16±2.48 months and allograft osteointegration of 12.41±5.47 months as described by Dolen et al and to the times described by Ceruso et al of 7 months or 8 months, respectively.[1,14,15] These results can be explained by the early venous thrombosis of flap. Janowski et al evaluated the effect of venous occlusion on the integration of a vascularized cortical bone graft and found that a vascularized autogenous cortical bone graft healed twice as quickly as conventional grafts, and that a vascularized graft with a venous occlusion was in an intermediate position.[16]

The time for full weight bearing in our patient was 5 months, opposed to an average time for full weight bearing of 13.7 months by Ceruso et al.[15] The initial stabilization after debridement provided host and local soft tissue conditions that enabled a successful delayed reconstruction as suggested by Dugan et al as well as the possibility for early range of motion exercises.[9] The patient showed an excellent progression during rehabilitation, tolerating partial weight bearing with full compliance. With radiographs showing a stable osteosynthesis with callous formation by 5 months, full weigh bearing was proposed to the patient, despite the risk of graft fracture.[1,14]

CONCLUSION

Managing SBDs of the distal femur requires a tailored approach. The technique, as described by Capanna, has a described overall 93.5% success rate, and allows for reconstruction with structural support, possibly reducing the risk of non-union and fracture, and represents a valid alternative in SBDs >6 cm.

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Ethical approval: Not required

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