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Case report

Distal femur nonunion treated with retrograde intramedullary nailing and RIA: a case report

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Summary. The current treatment of distal femur fractures includes locking plating and retrograde intramedullary nailing. These fractures are difficult to manage also for experienced surgeons, with results not always satisfactory. Reported nonunion rates now range from 0 to 34%. Factors associated with nonunion include comorbidities, such as obesity and diabetes, as well as the presence of open fractures, medial bone defects and comminuted fractures. This case report summarizes all of these assumptions and it concerns a 58 years old patient who underwent to 6 surgical procedures before to arrive to bone healing. (www.actabiomedica.it)

Key words: distal femur, fracture, nonunion, fixation, plating, nailing.

Introduction

Supra and intercondylar femur fractures are severe injuries that can be challenging also for more experienced surgeon. Although they account for less than 1% of all fractures and between 3% and 6% of femur fractures, their incidence is likely to increase; these types of traumas follow a bimodal age distribution in geriatric (low energy fractures) and young adult population (high energy traumas) (1-3).

The difficulties in their treatment increase in comminuted, intra-articular and open fractures. Their correct management includes the understanding of the fracture characteristics and a careful preoperative planning comprising implant selection.

The intra-articular fracture should be reduced anatomically and fixed in order to prevent postoperative knee osteoarthritis and stiffness. Metaphyseal comminution and bone loss, especially in open fractures, is a well-documented risk of nonunion and sometimes it is necessary to associate bone grafts that improve stability and healing processes (4, 5).

Current treatment options broadly include retrograde intramedullary nailing (RIMN) and open reduction and internal fixation (ORIF); in any case the surgical goal is to obtain best reduction and maximal stability.

This case report confirms the difficulties in the treatment of this type of fracture which healed only after a long period and multiple surgeries.

Case Presentation

This study was conducted in accordance with the principles of Declaration of Helsinki. Patient signed informed consent about the treatment he was subjected and the processing of his personal data.

A 58-year-old obese male was involved in a car accident and sustained a polytrauma characterized by an open comminuted intra-articular distal left femur fracture (figure 1) (AO/OTA 33-C3 and 2 Gustilo-Anderson classification) with bone loss and residual gap of about 6 cm at the level of the anterior and

Figure 1. Clinical assessment of the antero-distal exposure of the thigh.

medial metaphysis (figure 2), and ipsilateral fractures of the second and third metatarsals (figure 3), of the external proximal tibial plateau and of the patella and dislocation of the third metatarsophalangeal joint.

He was initially treated in emergency with debridement of the exposure, stabilization of the distal femur with an external fixator, screw fixation of the ipsilateral tibial fracture and of the metatarsals with Kirschner wires.

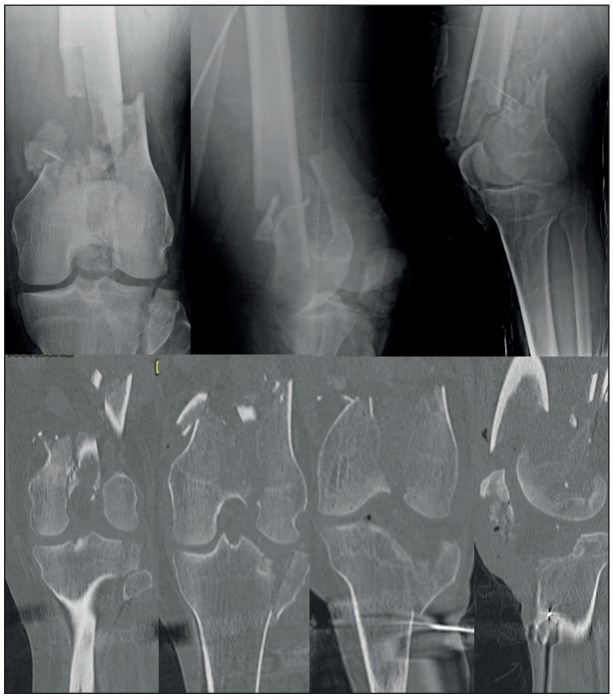

Figure 2. Preoperative knee radiographs and CT views

Figure 3. Preoperative left foot radiographs with fractures of the second and third metatarsals and dislocation of the third metatarsophalangeal joint

Seven days later the final osteosynthesis of the femur was performed with LISS plate and screws in association with anterior and medial cortical allograft; the patella was stabilized with screws (figure 5)

Two months later patients started assisted weigth bearing but in the following period x-rays showed cortical bone graft rupture and metal devices loosening (figure 6).

At this time inflammation indexes were high but scintigraphy with granulocytes excluded an acute infection. The patient underwent a second surgery in which the previous devices were removed and a new osteosynthesis with longer L.I.S.S. plate associated to another autologous cortical allograft and autologous bone from iliac crest was performed (figure 7).

Samples of tissue were taken from nonunion outbreak for microbiological/cultural tests. Bacteriological findings demonstrated Klebsiella Pneumoniae infection, which was treated with targeted antibiotic therapy, up to normalize the inflammation indexes (about 2 months) and another scintigraphy did not show signs of infection.

Eight months after this second surgery patient complained of a sudden pain during walking. The

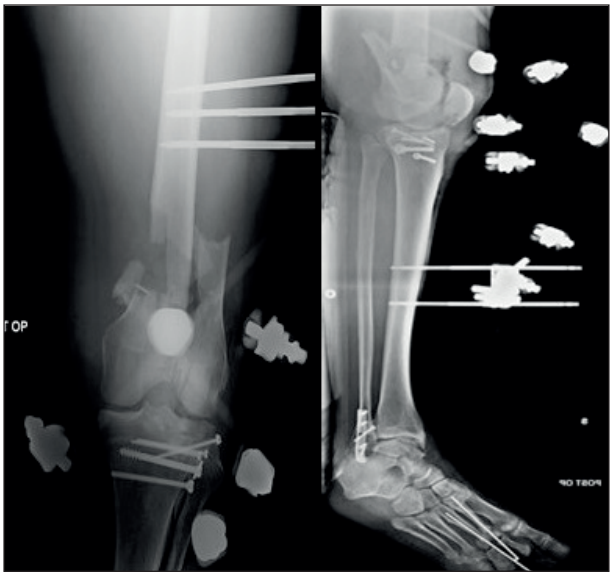

Figure 4. Postoperative x-rays after acute initial surgery

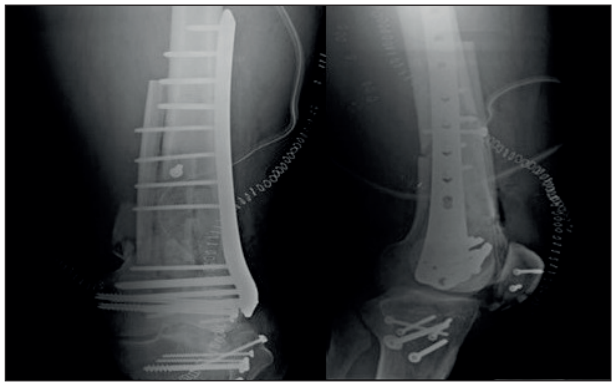

Figure 5. Postoperative radiographs following surgery 7 days after injury

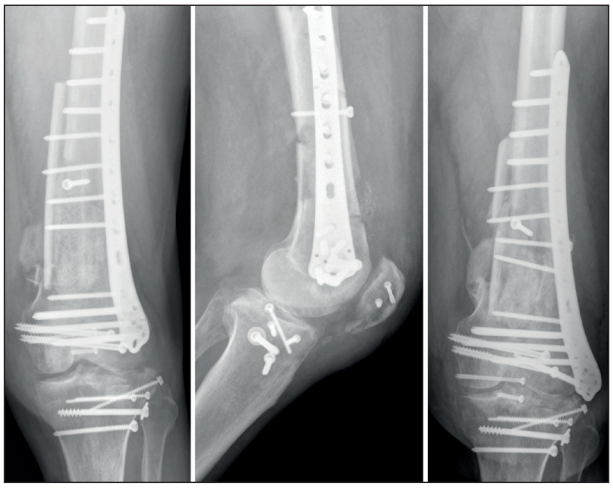

Figure 6. X-rays views 2 and 4 months after surgery with rupture of the cortical graft and device loosening

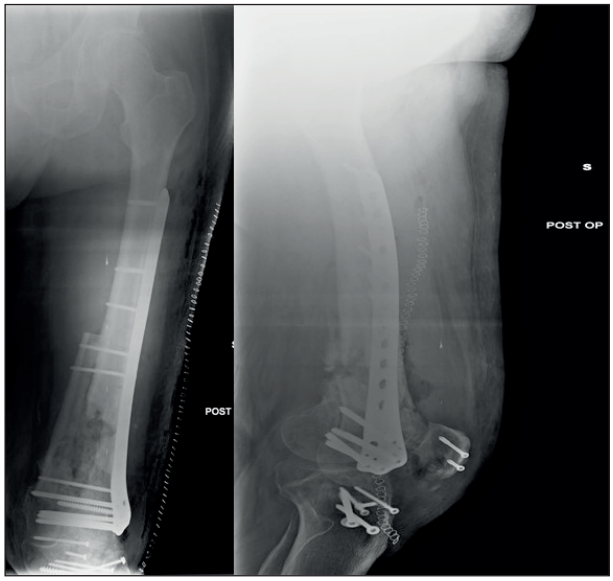

Figure 7. X-rays views after second procedure of osteosynthesis

radiological evaluation revealed the rupture of the plate and cortical graft in a framework of nonunion of the metaphyseal fracture, despite healing of its articular component. Elevated inflammation indexes as well as positive scintigraphy led us to suspect an underlying silent infection (figure 8).

As consequence metallic devices were removed, a large bone resection was performed at the pseudoarthrosis stump, multiple tissue material samples were taken for microbiological/culture tests and an antibiotic-based cement spacer (gentamicin) was placed, according to the Masquelet technique. Temporary fixation was obtained with external fixator (figure 9).

Staphylococcus aureus infection was treated with specific antibiotic therapy for two months. After normalization of the inflammation indexes with negative granulocyte scintigraphy, after 3 months of Masquelet, the final surgery was performed. A retrograde intramedullary nail combined with bone marrow taken from the contralateral femur with the RIA technique and cadaveric bone grafts was applied (figure 10).

The patient started assisted weigth bearing after 2 months and 4 months following last surgery x-rays showed the breakage of the proximal static locking screw, which was removed (figure 11).

The subsequent monthly checks showed progressive radiological and clinical improvements. Eight months after RIMN pain was absent, patients walked without crutches and x-rays showed consolidation (figure 12).

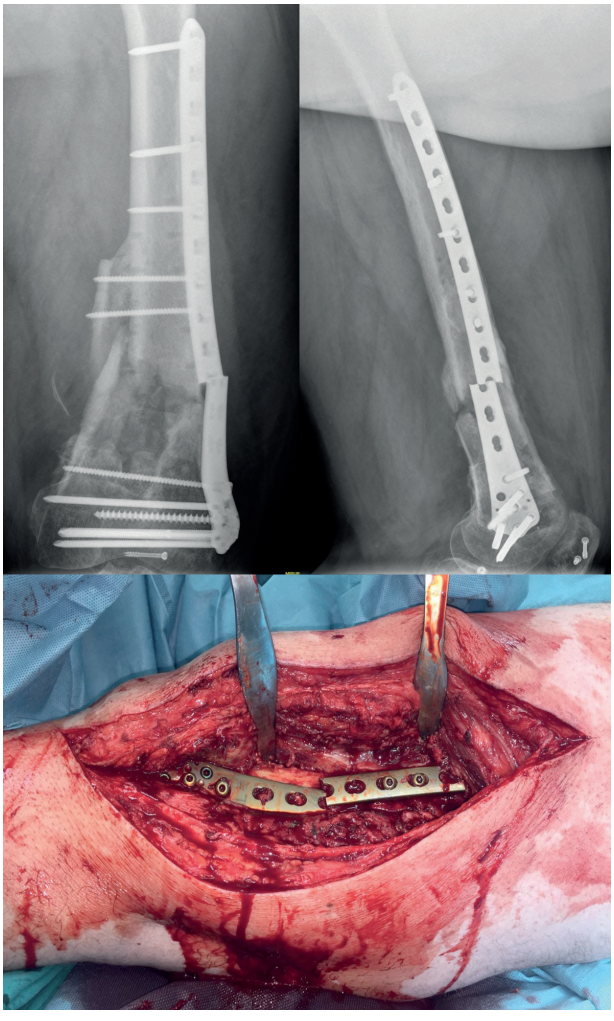

Figure 8. Plate's and cortical graft rupture. Radiographs and intraoperative view

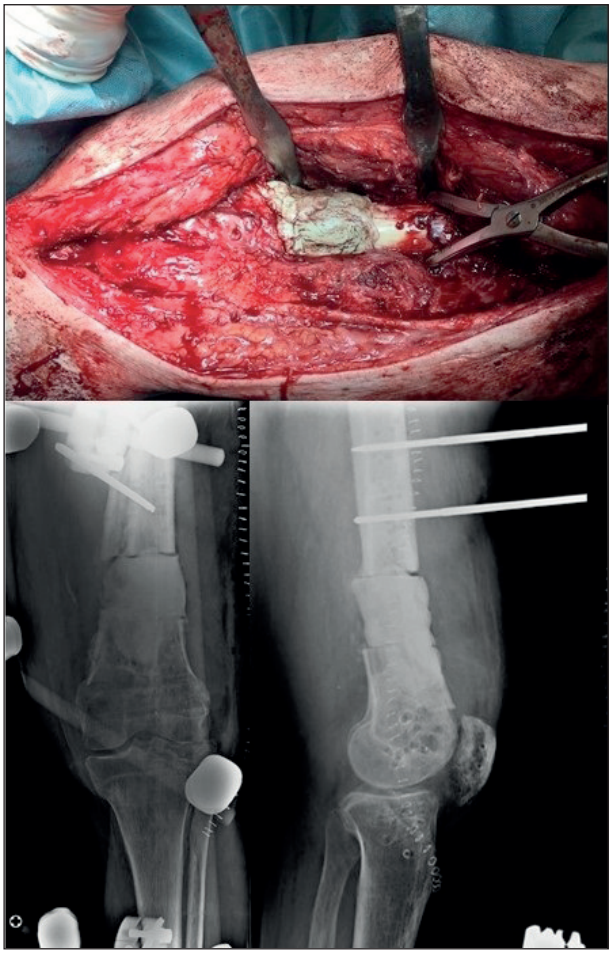

Figure 9. In situ cement spacer and external fixation; intraoperative view and x-rays

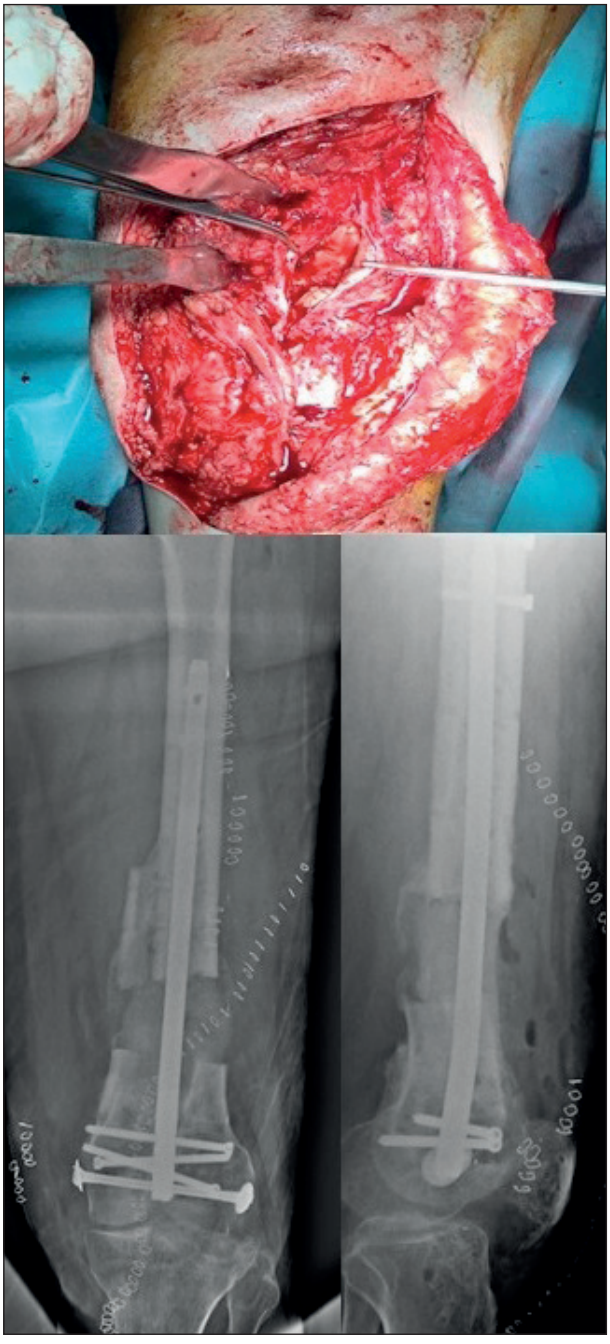

Figure 10. Induced membrane after cement removal and radiographs after RIMN and bone marrow and grafts positioning

Discussion

Distal femur fractures not rarely are characterized by unsatisfactory results; this is also the consequence of their severity that makes these injuries technically challenging to operatively treat also for experienced orthopaedics surgeons (4).

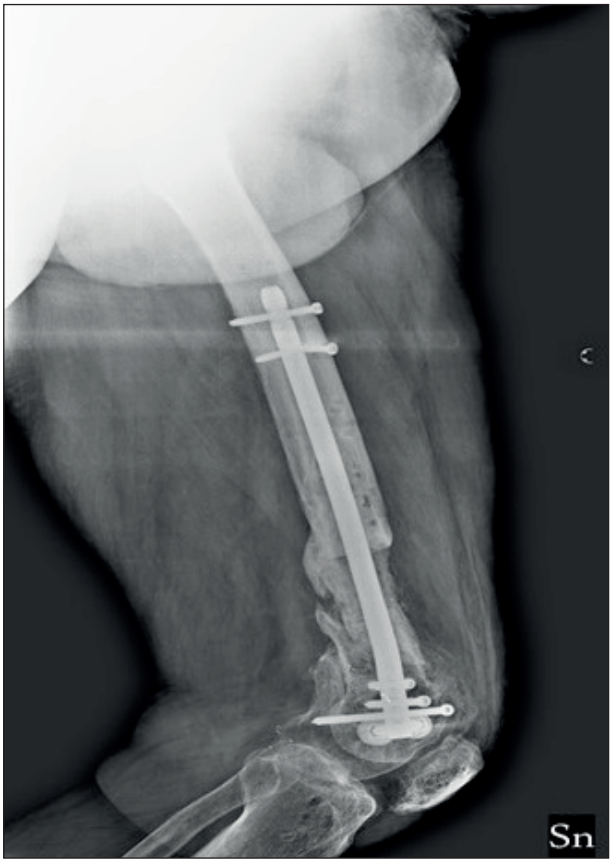

Figure 11. Rupture of the proximal static locking screw.

In the early 1960s, most distal femur fractures were managed conservatively with fracture bracing and traction, achieving acceptable results in 67% to 90% of patients (6). However, with the advent of new surgical techniques and implants, the pendulum shifted from conservative management to surgical stabilization. Through historical review, Henderson and colleagues chronicled the increasing success rates with operative fixation from 52% to 54% in the 1960s, 73.5% to 75% in the 1970s, to 74% to 80% in the 1980s. Steady advances in our understanding of distal femoral anatomy and fracture biology have heralded various implant designs that further optimized successful treatment of these injuries (6).

Nowadays, surgical treatment can either be RIMN or plate fixation, with plate fixation having a wide indication for various fractures types (5, 6); bone grafts can be associated (7-9).

Figure 12. X-rays and clinical evaluation 8 months after last surgery with consolidation of the fracture

Recently, many studies have shown results of the LCP fixation and RIMN fixation. LCP and RIMN have been reported to yield better outcomes than traditional non-locking plates (10). Data from large retrospective cohorts (10-13) suggest that there were no significant differences in clinical outcomes, including time to union and union rates, in patients who underwent LCP and RIMN fixation of the distal femur after fracture.

However, the non union rate lies between 0 and 34%, indicating considerable variation (1,14).

Risk factors for non union and delayed bone union in distal femoral fractures include the presence of open fractures, medial bone defects, obesity and comminuted fractures (14,15) as well as surgical mistakes.

In this case report, in which multiple surgeries were necessary to reach bone healing, all these factors were present.

Authors believe that their initial treatment should be criticized for timing (only 7 days from open fracture to definitive surgical treatment) and methodology. The delicate approach of a multi-fragmentary metadiaphyseal and articular fracture should require a system of synthesis that leads to absolute stability, while avoiding the rigidity of the system itself.

The stable plate-screws connection typical of LISS construct, which reduces the risk of secondary loss of reduction providing stability of the implant, could be compromised by wrong choice of plate length and screw positioning.

The guidelines reported by Gautier et al. suggested that a locking compression plate should be used as a bridging plate in order to achieve relative stability. Additionally, the researchers recommended that the plate length used in simple fractures should be 8–10 times longer than the fracture length, 0–3 empty holes should be left in the surrounding space, the distance space should be ≤ 2 mm, and ≥ 3 screws should be inserted (bicortically) into the proximal and distal bone fragments (16). For comminuted fractures, the guidelines recommend that the plate length should be at least 2–3 times longer than the fracture length and ≥ 3 empty holes should be left in the surrounding fracture site.

For these reasons, Authors are critics on their first fixation surgery; plate was too short and together with the cortical graft both determined too much rigidity and the subsequent failure of the synthesis.

Authors also believe that second osteosynthesis was biomechanically better (plate longer and a more dynamic screws positioning) but at this time there was an underestimation of the below infection.

Finally, last surgery determined bone healing as consequence of a precise global management of the infected nonunion (association of specific antibiotic therapy, Masquelet technique, RIMN and marrow and bone grafts) (17-19).

Though, RIMN demonstrated a significantly higher malunion rate when compared with locked plating (20), Authors are confident that they have restored a good axis to the lower limb without disruption of extensor apparatus (21). This is an important fact with a view to future prosthesis (22-25), that, in this case, has to be considered unavoidable as consequence of the combined articular fractures of femur, patella and proximal tibia.

Conclusion

Nonunions are frequent complications in these patterns of fractures; it is difficult to choose an adequate synthesis, to correctly balance the biological and mechanical stimulus. In this specific case the exposition of the fracture, obesity and the superinfection further hindered the healing precesses. The success of the treatment depends on not underestimating infection and to create a fixation which guarantees this balance. Furthermore, autoologous bone marrow and bone grafts are essentials in osteoinduction of healing processes.

Conflict of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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