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Two-stage treatment for infected nonunion of the humerus: a case report

C. Puma Pagliarello, G. Testa, A.A. Lombardini, G. Condorelli, V. Pavone

Clinica Ortopedica, A.O Vittorio Emanuele Catania, Catania, Italy

ABSTRACT:

The authors present a case of infected non-union of the humerus treated by a two-stage procedure. In the first stage, a wide curettage of the septic tissue and a bone resection were performed introducing an antibiotic spacer. In the second stage, reconstruction of the humerus, fixation with intramedullary antibiotic nail, and bone graft were performed. A 1-year follow-up after the surgical procedure showed an excellent functional outcome, with no evidence of infection.

INTRODUCTION

Infected non-union of the humerus is a chronic and debilitating disorder, which represents a very complex problem for the surgeon both in terms of costs and time-effective treatment. It is one of the most common complications of humeral fractures with an incidence ranging between 2% and 30%[1]. The rate varies between 2%-13% in non-operative approaches, and between 15% to 30% in surgical treatments[2]. Several risk-factors have been identified, some of them being patient-related such as age, sex, tobacco smoke, metabolic disorders and nutritional deficiencies. Patient independent risks include: fracture type and location, soft tissue injury, type of surgical treatment and the presence of an infection[3]. Many attempts have been done to identify specific fracture patterns that could predispose to non-union; transverse and short oblique fractures appear to be the most susceptible to non-union[4]. The authors present the case of infected non-union of the humerus treated in two stages with an excellent functional outcome and no evidence of infection at 1-year follow-up.

PATIENTS AND METHODS

A 33-years old male with unremarkable clinical history was treated conservatively for a short oblique humeral shaft fracture type 12A1 AO classification caused by domestic trauma. Approximately seven months after the trauma the patient came to our attention complaining of local pain and moderate functional limitation of the upper limb. The physical examination showed abnormal painless movements at the middle third of the arm with no local swelling or redness and no signs of neurovascular injuries or local inflammation. Shoulder motion was 40° of elevation, 0° of internal and external rotation. The elbow presented 45° of extension, 80° of flexion and complete forearm prono-supination. The radiological examination highlighted a humerus non-union (Fig. 1). The patient was afebrile with the following inflammatory values: C-Reactive Protein (CRP) of 7 mg/L and Erythrocyte Sedimentation Rate (ESR) of 7 mm. After an accurate pre-operative planning, debridement of the fracture site, wide resection of the infected bone, and the introduction of custom-made antibiotic spacer were performed (Fig. 2). During the procedure, bioptic samples were taken and clindamycin sensitive "Staphylococcus Hominis" was isolated. After consultation with the infectious diseases specialist, the patient underwent antibiotic treatment with clindamycin 600 mg each 12 h for 30 days. A humeral brace was applied. After 2 months laboratory values were normalized (CRP of 3 mg/L and ESR of 2 mm) and there were no radiographic findings of infection together with a negative CT-scan. The second stage treatment with humerus surgical reconstruction was planned. Under loco-regional anesthesia was performed, with the patient in beach chair position assisted by a Mobile C-arm X-Ray System, through lateral transdeltoid approach and lateral humerus approach on the preceding surgical scars. The surgical site showed no signs of infected tissue and the antibiotic spacer was removed.

Corresponding Author: Calogero Puma Pagliarello, MD; e-mail: calogero.puma90@gmail.com

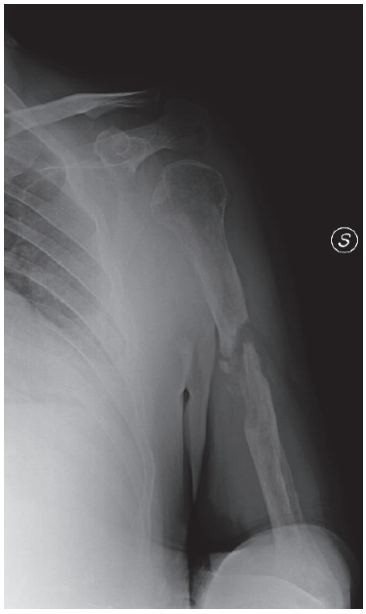

Figure 1. X-Ray showing humeral non-union seven months after the fracture.

Figure 2. X-ray control after first surgical treatment: debridement of the fracture site, widely infected bone resection and the introduction of c ustom-made antibiotic spacer.

The humeral canal was reamed, and a 7 cm bone graft was positioned within the gap. An antibiotic cement-impregnated intramedullary nail (a dynamic long nail of 7 mm in diameter and 280 mm in length) was then introduced into the medullary canal nailing the graft, and it was locked with two cephalic screws of 5 mm in diameter and of 40 mm in length proximally, distally with one cortical screw of 3.5 mm in diameter and 30 mm in length. Finally, 10 cc of osteostimulative bioactive glass granules (Bonalive®) was used to fill the gap between the allograft and the healthy bone (Fig. 3). The procedure was well tolerated by patient. All the samples taken during the procedure were negative for infection. The patient was then immobilized applying a cast for 3 weeks and a physical therapy program was started.

RESULTS

Clinical and radiological follow-up with blood test at 1, 3 and 5 months (Fig. 4) after the procedure did not show any signs of infection with inflammatory indexes within the range of normality.

Figure 3. 5 months follow-up after definitive treatment: antibiotic spacer removal, bone graft and antibiotic cement-impregnated intramedullary nail implant.

Figure 4. 5 months clinical follow-up.

DISCUSSION

We report a case of an infected humerus non-union treated by a two-stage procedure. The first stage consists of wide curettage, infected bone resection and custom-made cemented spacer introduction. Reconstructive surgery was performed in the second stage, when the infection was resolved, using an antibiotic cement-impregnated intramedullary nail with bone allograft. The result was healing of the fracture with good functional results and no evidence of infection at 1 year. If the diagnosis is easy to be obtained by laboratory values, intra-operative culture samples and imaging findings, treatment represents a challenge for the surgeon. The infected non-union leads to sclerotic margins covered with a thickened periosteum and scarred muscles that envelope a relatively avascular bone. These features explain the low effectiveness of systemic antibiotic therapy. Debridement, rigid fixation and prolonged antibiotics, represent the key points for the treatment of infected non-union of long bones[5-7]. In the first stage is mandatory to treat the infections with systemic antibiotic therapy, wide curettage of the infected soft tissue, and necrotic bone resection. The latter leads to the presence of a bone defect, increasing the complexity of the management[8]. The use of a custom-made cement spacer after resection allows to maintain the limb length; also, it induces the formation of a pseudo-synovial membrane around it, producing growth and osteoinductive factors, favoring human bone marrow stromal cells differentiation to the osteoblastic lineage[9]. The aim of the second stage of non-union surgery is to achieve stable internal fixation to obtain early functional restoration. Several techniques have been described including locking intramedullary nails, unilateral external fixators, circular external fixators, and compression plating. Biological enhancement with autologous graft, growth factors, and PRP, are widely used with good results (Table 1)[10-14]. Nowadays antibiotic cement-impregnated intramedullary nail seems to be a good option for the surgical treatment of the humeral shaft infected non-union. It has biological and biomechanical advantages over antibiotic beads, providing more intimal contact with the medullary canal and more elution of antibiotic to the endosteal surface. Antibiotic beads placed directly in the medullary canal will become trapped in a few weeks and they can be difficult to remove. On the other hand, the cement nail is easier to remove due to its smooth surface. At least it provides stability to promote infection healing[15].

CONCLUSIONS

The treatment of humerus-infected non-union is a challenge for the orthopedic surgeon. The use of an antibiotic cement-impregnated intramedullary nail, associated to systemic antibiotic therapy, is a valid option of treatment.

Table 1. Treatment options of long bones non-unions with bone defects advantages and disadvantages

Treatment	Advantages	Disadvantages
Limb Shortening	Enables bone healing to begin immediately Assists soft tissue coverage by reducing the defect size or soft tissue tension	Functional loss
Distraction Osteogenesis	Stimulates local blood flow (and angiogenesis) Produces good quality bone Can be applied to bone defects 2-10 cm in size	Requires patient compliance Technically difficult Risk of pin-tract infection, delayed union, joint contracture and chronic pain. Wire transfixation can cause soft-tissue tethering and loss of limb function
Autograft	Short union time High union rates	Donor site morbidity Limited graft availability Demanding surgical technique Risk of inadequate graft hypertrophy and stress fracture
Allograft	Available in large quantities Technically undemanding	Less osteoinductive than autografts Expensive to store Risk of disease transmission and immunogenic response
Allograft + BMPs	Short union time High union rates Heterotopic bone	Muscle ossification
Antibiotic Cemented Rods	Support to the fracture or non-union site while the infection is under treatment. Possibility to remove the rod and replace with a definitive metal intramedullary nail	Fracture of the rod

Conflict of Interests:
The Authors declare that they have no conflict of interests.

REFERENCES

1. Bassiony AA, Almoatasem AM, Abdelhady AM, Assal MK, Fayad TA. Infected non-union of the humerus after failure of surgical treatment: management using the orthofix external fixator. Ann Acad Med 2009; 38; 1090-1094.
2. Volgas DA, Stannard JP, Alonso JE. Nonunion of the humerus. Clin Orthop Relat Res 2004; 419: 46-50.
3. Hak DJ, Fitzpatrick D, Bishop JA, Marsh JL, Tilp S, Schnettler R, Simpson H, Alt V. Delayed union and nonunions: epidemiology, clinical issues, and financial aspects. Injury 2014; 45; S3-S7.
4. Healy WL, White GM, Mick CA, Brooker AFJ, Weiland AJ. Nonunion of the humeral shaft. Clin Orthop Relat Res 1987; 219; 206-213.
5. Ring D, Jupiter JB, Gan BS, Israeli R, Yaremchuk MJ. Infected nonunion of the tibia. Clin Orthop Relat Res 1999; 369; 302-311.
6. Jain AK, Sinha S. Infected nonunion of the long bones. Clin Orthop Relat Res 2005; 431: 57-65.
7. Struijs PA, Poolman RW, Bhandari M. Infected nonunion of the long bones. J Orthop Trauma 2007; 21; 507-511.
8. Lowenberg DW, Feibel RJ, Louie KW, Eshima I. Combined muscle flap and Ilizarov reconstruction for bone and soft tissue defects. Clin Orthop Relat Res 1996; 332; 37-51.
9. Pelissier P, Masquelet AC, Bareille R, Pelissier SM, Amedee J. Induced membranes secrete growth factors including vascular and osteoinductive factors and could stimulate bone regeneration. J Orthop Res 2004; 22: 73-79.
10. Giannoudis PV, Ahmad MA, Mineo GV, Tosounidis TI, Calori GM, Kanakaris NK. Subtrochanteric fracture nonunions with implant failure managed with the ‘ Diamond ’ concept. Injury 2013; 44; S76-S81.
11. Homma Y, Zimmermann G, Hernigou P. Cellular therapies for the treatment of non-union: the past, present and future. Injury 2013; 44; S46-S49.
12. Ashman O, Phillips AM. Treatment of non-unions with bone defects: which option and why? Injury 2013; 44; S43-S45.
13. Blokhuis TJ, Calori GM, Schmidmaier G. Autograft versus BMPs for the treatment of non-unions: what is the evidence? Injury 2013; 44; S40-S42.
14. Ronga M, Fagetti A, Canton G, Paiusco E, Surace MF, Cherubino P. Clinical applications of growth factors in bone injuries: experience with BMPs. Injury 2013; 44; S34-S39.
15. Paley D, Herzenberg JE. Intramedullary infections treated with antibiotic cement rods: preliminary results in nine cases. J Orthop Trauma 2002; 16: 723-729.