



Treatment of recalcitrant atrophic non-union of the humeral shaft with BMP-7, autologous bone graft and hydroxyapatite pellets



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ABSTRACT

Recalcitrant humeral non-union is a disabling condition that is extremely difficult to treat. The use of BMP-7 has been proposed to improve bone healing. This is a report of the results obtained in 12 patients with recalcitrant humeral non-union treated using stable fixation with a long locking compression plate and BMP-7, autologous bone graft and hydroxyapatite pellets applied at the non-union site. Patients had up to three surgical attempts at non-union healing prior to our treatment. The average time from the initial fracture to our surgery was 5.2 years. Average follow-up was 5.3 years. At follow-up, non-union had healed in all patients by an average of 7.3 months. All the patients were very satisfied with their final results, despite a restricted range of motion of the elbow and a moderate muscular atrophy, which was frequently observed. Our study shows that BMP-7 associated with autologous bone grafting and hydroxyapatite pellets after stable fixation is an effective adjuvant to stimulate bone healing in the treatment of recalcitrant humeral non-union.

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Introduction

Non-union is a late complication of humeral shaft fractures that may occur after both conservative and surgical treatment. The incidence of non-union varies from 2% to 15%; however, it seems to be more common after surgical treatment of humeral fractures [1–4]. The general risk factors that may predispose to non-union are obesity, alcohol abuse, use of steroids, anticoagulants and anti-inflammatory drugs, poor bone quality and smoking [5,6]. Local risk factors include transverse fracture pattern, soft tissue interposition, infection and inadequate treatment [7]. Treatment of humeral shaft non-union may be difficult, and many surgical options have been reported with varying success rates. Surgical debridement of the non-union site and internal fixation with a locking compression plate combined with autologous bone grafting has been proposed as the first choice treatment for humeral shaft non-union [8–15]. However, good results have also been reported with intramedullary nailing and external fixators [11,16–23]. When traditional treatment options fail, non-union is considered resistant or recalcitrant to healing, and treatment becomes a challenge for the orthopaedic surgeon. In these cases, some authors have suggested the use of bone morphogenetic

proteins (BMPs), which are biological osteoinductive agents that stimulate bone healing [24–26]. Recombinant BMP-7 (osteogenic protein-1 [OP-1]) represents the most common BMP utilised for treatment of non-union [27–40].

The aim of this study was to report a series of 12 recalcitrant atrophic humeral non-unions that were surgically stabilised by a locking compression plate, with the addition of BMP-7 (OP-1), autologous bone grafting and hydroxyapatite pellets, and followed-up for at least two years after treatment.

Materials and Methods

A total of 12 patients underwent surgery for atrophic recalcitrant non-union of the humeral shaft from 2003 to 2011. Surgery consisted of debridement of the non-union site, stabilisation with a compression plate and application of OP-1 plus autologous bone graft and hydroxyapatite pellets. There were no clinical or radiographic signs of infection in any patient. Recalcitrant was defined as a humeral shaft non-union in which at least one previous surgical treatment performed for the non-union had failed. All the patients agreed to come to our hospital for a follow-up evaluation. Eight patients were female and four were male; the right side was involved in five patients and the left side in seven. The initial treatment of the humeral fracture was performed in another hospital for all patients. Initial treatment was conservative in two patients and surgical in 10: after reduction, fracture was

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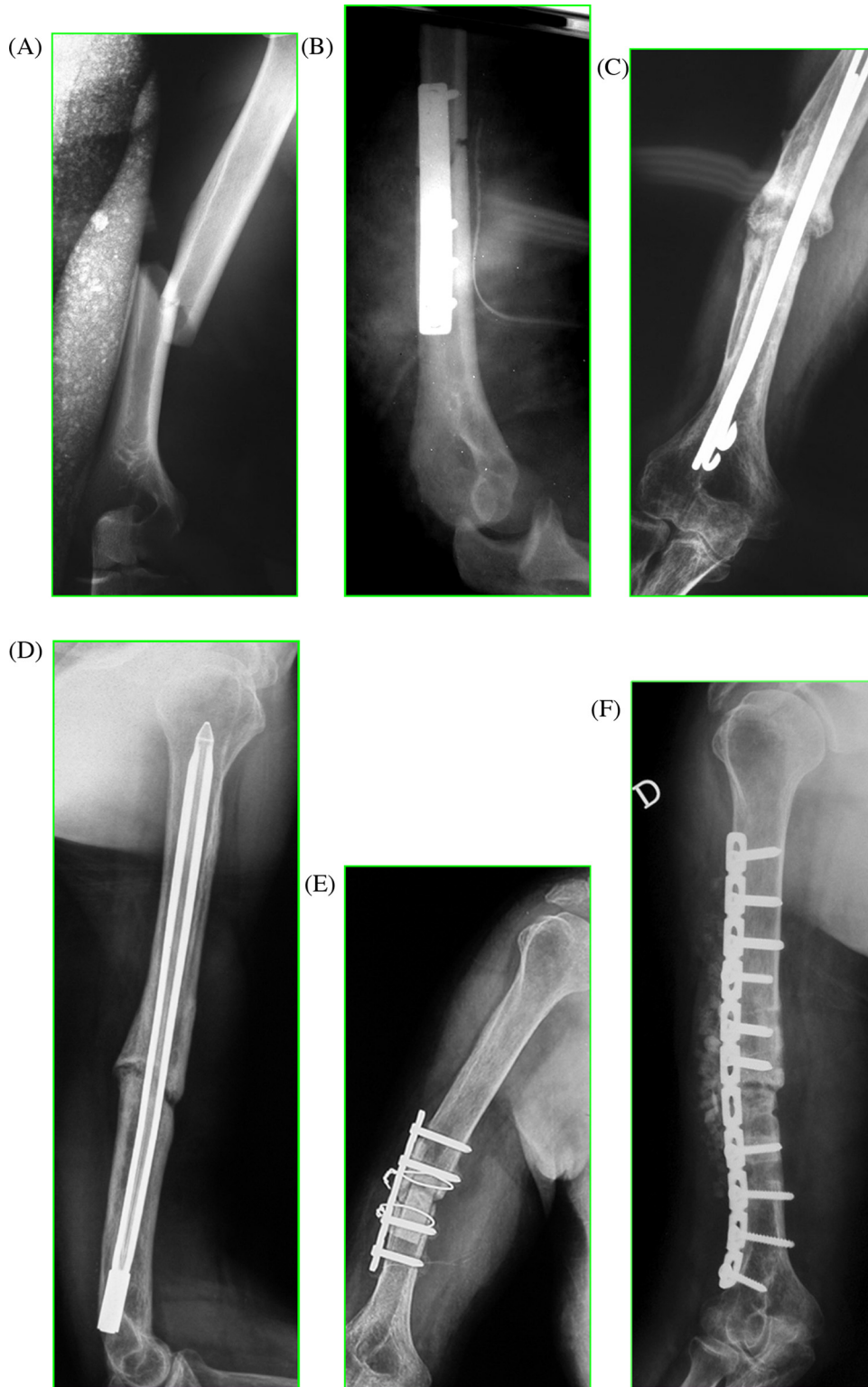


Fig. 1. A,B) Fracture of the humeral diaphysis in a 39-year-old patient surgically reduced and stabilised with a short peripheral plate. C) One year later, non-union developed and it was fixed by three retrograde anchor nails. D) Another year later, non-union was still present, and a new closed reduction and internal fixation with a single retrograde nail was performed. E) Two years later, a third surgical procedure was performed: the non-union was fixed with a short plate and cerclage wiring and cortico-cancellous bone grafts were applied, but this procedure also failed. F) Eight months later, the non-union was fixed by a long locking compression plate with an autologous bone graft, but three months later, the patient had a car accident and the plate broke (G). H,I) The patient came to our hospital, where a fourth operation was performed: the non-union was reduced again and stabilised using a new long locking compression plate, but autologous bone graft plus OP-1 and hydroxyapatite pellets were also applied. J,K) At follow-up, four years after the last operation, the non-union was healed; the patient's elbow joint was painful after strenuous activities and a mild restriction of the elbow ROM was present, but he was very satisfied with the final result (Case 6—Table 1).

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