VOLUME - 15, ISSUE - 02, FEBRUARY - 2026 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Orthopaedics

MANAGEMENT OF ASEPTIC FOREARM SHAFT NON-UNION USING COMPRESSION PLATE FIXATION AND AUTOLOGOUS BONE GRAFTING: A CASE SERIES

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ABSTRACT

Background: Forearm shaft non-union is an uncommon but disabling complication following diaphyseal fractures, leading to pain, deformity, and loss of forearm rotation. Optimal management requires restoration of both mechanical stability and biological healing potential. **Methods:** This case series includes three adult patients with aseptic non-union of the ulna or both forearm bones following failed operative fixation. All patients underwent revision surgery with implant removal where required, meticulous debridement, autologous cancellous bone grafting, and stable plate osteosynthesis. Radiological union and functional recovery were assessed during follow-up. **Results:** All three patients achieved radiological union between 12 and 18 weeks. At final follow-up, each patient demonstrated full, pain-free range of motion of the elbow, wrist, and forearm, with no implant-related complications or need for re-operation. **Conclusion:** Compression plate fixation combined with autologous bone grafting is an effective and reproducible strategy for achieving early union and excellent functional outcomes in forearm non-union.

KEYWORDS :

INTRODUCTION

Diaphyseal fractures of the radius and ulna disrupt the forearm's complex biomechanics and can impair pronation and supination. Although most acute fractures heal uneventfully with operative fixation, failure to unite remains a serious challenge [1]. The U.S. Food and Drug Administration defines non-union as a fracture that has not healed within nine months and shows no radiographic evidence of progression for three consecutive months. In population studies, non-union develops in approximately 2–10 % of forearm fractures, with the highest incidence among adults aged 35–44 years and a predominance in post-menopausal women [2]. Mechanical factors (unstable fixation, distraction or malalignment) and biological factors (soft-tissue compromise, infection or impaired vascularity) contribute to the pathogenesis. Weber and Cech's classification distinguishes hypertrophic non-union, which reflects inadequate stabilization and abundant callus, from oligotrophic and atrophic types, where biological failure leads to little or no callus formation.

Surgical management aims to correct both mechanical and biological deficiencies. Dynamic compression plating with autologous bone grafting is widely regarded as the gold standard because it allows anatomical reduction, rigid stabilization and early rehabilitation [3]. Compression restores stability while autologous cancellous graft provides osteogenic and osteo-inductive stimulus; this combination is considered the keystone of non-union treatment [4]. Large series using this strategy report union in the majority of cases but highlight that functional outcomes vary and recovery may take months. Contemporary data show that locking plates lacking compression features are associated with higher non-union rates than dynamic compression plates. Comparative studies also demonstrate superior union rates with plate fixation (100 %) compared with intramedullary nailing (86 %) [5].

Despite advances, forearm non-union continues to cause pain, deformity and functional limitation, and revision surgery often requires tailored approaches addressing implant failure, bone loss or compromised soft tissue. The present case series examines three adult patients with aseptic non-union of the ulna or both forearm bones treated with revision plating and autologous bone grafting. The aim is to correlate surgical decision-making with current literature and to highlight factors that may influence healing and functional recovery.

METHODOLOGY

This case series includes three adult patients presenting with established non-union of forearm shaft fractures following prior operative management of closed injuries. All patients underwent clinical evaluation and radiographic assessment to confirm the diagnosis and type of non-union. Revision surgery was performed using standard surgical principles, including removal of failed implants where present, thorough debridement of the non-union site, restoration of anatomical alignment, autologous cancellous bone grafting, and stable internal fixation using plate osteosynthesis. Plate selection (locking or non-locking dynamic compression plate) was based on fracture characteristics and bone quality. Postoperatively, patients were managed with short-term immobilization followed by a standardized, progressive rehabilitation protocol. Radiological union and functional recovery were assessed during regular follow-up visits.

Case Descriptions

Case 1

A 50-year-old male presented with pain and functional limitation of the forearm due to a non-union of the ulna shaft following previous surgical fixation for a closed fracture. Pre-operative radiographs demonstrated absence of bridging callus and features consistent with established non-union (Figure 1a). Revision surgery was undertaken, which included exposure of the non-union site, removal of fibrous tissue, freshening of bone ends, and autologous cancellous bone grafting, followed by stable plate fixation. Intra-operative photographs document adequate debridement and restoration of anatomical alignment (Figure 1b). Post-operative radiographs showed satisfactory implant position and compression across the non-union site (Figure 1c). Progressive mobilization was initiated after initial immobilization. Radiological union was achieved by 12 weeks, as evidenced by bridging trabeculae on follow-up radiographs. Clinical photographs at final follow-up demonstrated full, pain-free range of motion of the elbow, wrist, and forearm without residual deformity (Figure 1d).

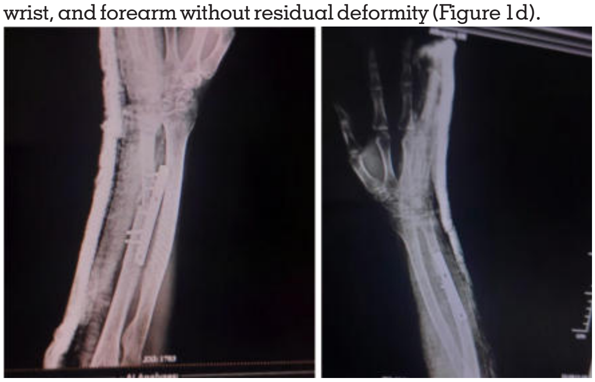

Fig 1. Case 1 Preop Xrays

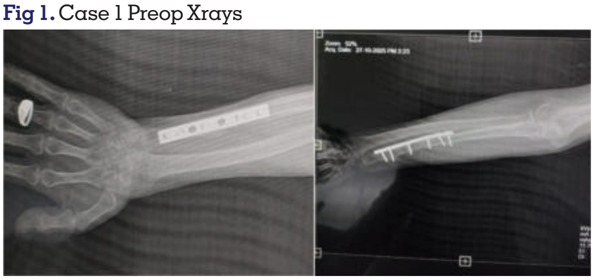

Fig 2. Case 1 Postop Xrays

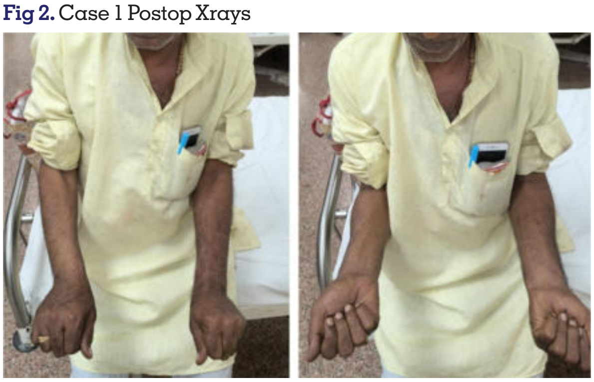

Fig 3. Case 1 Postop Clinical photos

Case 2

A 35-year-old male presented with persistent pain and restricted forearm rotation following prior operative management of a closed both-bone forearm fracture. Pre-operative radiographs confirmed non-union of both the radius and ulna shafts (Figure 2a). Revision surgery involved careful exposure of both non-union sites, thorough debridement, autologous bone grafting, and fixation using locking dynamic compression plates to achieve rigid stabilization. Intra-operative images demonstrate appropriate plate placement and restoration of forearm alignment (Figure 2b). Immediate post-operative radiographs confirmed optimal implant positioning and satisfactory reduction of both bones (Figure 2c). A structured rehabilitation protocol emphasizing early controlled motion was followed. Serial radiographs showed progressive callus formation, with complete union achieved at 18 weeks. At final follow-up, clinical photographs revealed complete recovery of pronation and supination, along with full elbow and wrist motion, and the patient had returned to unrestricted daily activities (Figure 2d).

Fig 4. Case 2 Preop Xrays

Fig 5. Case 2 Postop Xrays

Fig 6. Case 2 Postop Clinical photos

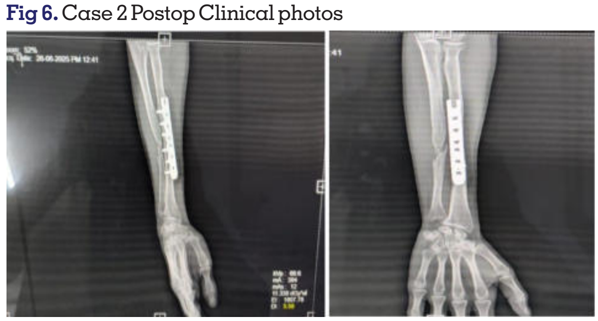

Fig 7. Case 3 Preop Xrays

Case 3

A 28-year-old female presented with an atrophic non-union of the mid-shaft ulna following failed intramedullary nailing for a closed fracture. Pre-operative radiographs revealed absence of callus formation and sclerotic bone ends consistent with atrophic non-union (Figure 3a). Revision surgery was performed with removal of the intramedullary nail, excision of fibrous tissue, autologous cancellous bone grafting, and stabilization using a non-locking narrow dynamic compression plate. Intra-operative photographs highlight the non-union site preparation and stable plate fixation (Figure 3b). Post-operative radiographs demonstrated adequate compression and alignment across the fracture site (Figure 3c). Gradual mobilization was initiated following early fracture stability. Radiological union was achieved by 16 weeks. At final follow-up, clinical assessment and photographs confirmed full, pain-free range of motion of the forearm, elbow, and wrist, with no functional limitation (Figure 3d).

Fig 8. Case 3 Postop Xrays

Fig 9. Case 3 Postop Clinical photos

DISCUSSION

Forearm non-union is an uncommon but debilitating consequence of diaphyseal fractures. It occurs in roughly 2–10 % of fractures and is more common in adults aged 35–44 years. Non-union arises from a combination of mechanical and biological factors; therefore, classification systems such as Weber–Cech distinguish hypertrophic non-unions, which show exuberant callus due to inadequate stabilization, from atrophic non-unions, which exhibit little callus and reflect biological failure with poor vascularity . The cases here reflect these patterns: Case 1 and Case 2 were oligotrophic non-unions after previous plating, whereas Case 3 was an atrophic non-union after intramedullary nailing, characterized by a fibrous gap and minimal callus [6]. Management of non-union should address both stability and biology, starting with removal of failed implants, radical debridement, restoration of alignment and length, and introduction of osteo-inductive stimulus [7].

Open reduction and internal fixation with compression plating remains the gold-standard for diaphyseal forearm fractures, achieving anatomical reduction and stable fixation while allowing early motion. Our approach followed AO principles: thorough debridement, exchange of hardware, autologous cancellous bone grafting and dynamic compression plating. Bone graft was sourced from the iliac crest and used in all cases to restore biology [8]. Autologous grafting is considered the keystone of non-union treatment and provides osteogenic, osteo-inductive and osteo-conductive properties; it is especially necessary in atrophic or oligotrophic non-union to fill gaps and stimulate healing. The success of our cases-union in 12 weeks (Case 1), 18 weeks (Case 2) and 16 weeks (Case 3) with full recovery of forearm rotation-supports the importance of stable plate fixation and biological augmentation.

Our results compare favorably with published series. In a prospective study of 20 forearm non-unions treated with dynamic compression plating and iliac-crest bone grafting, Kenan and Habib reported union in a median of five months, with 18 of 20 patients healing within four months and 55 % rated as excellent [9]. Another large series of 47 non-unions treated with compression plate fixation and autogenous bone grafting achieved 100 % union but required a median of seven months and only 62 % were rated excellent, highlighting the challenge of restoring function despite union [10]. Our union times (12–18 weeks) lie at the lower end of published ranges and all patients regained full pronation–supination and elbow/wrist motion, suggesting that meticulous debridement, restoration of alignment and early rehabilitation may improve functional outcomes.

The third case illustrates the limitation of intramedullary nailing for forearm fractures. Elastic stable intramedullary nailing is minimally invasive, but studies show higher ulnar non-union rates with anterograde nails compared with retrograde nails and less frequent radial non-union due to inherent compression. A meta-analysis comparing plate fixation to intramedullary nails reported 100 % union in the plating group versus 86 % in the nailing group, with delayed and non-union limited to the nailing cohort. Our case of nail failure and subsequent successful plate fixation underscores the need for stable compression in adult forearm non-unions [11]

Choice of plate also matters. A recent multicenter study found that locking plates without compression functionality had higher non-union rates (18.5 %) compared with locking compression plates and dynamic compression plates (11.2 % and 6.2 %, respectively), with logistic regression identifying use of non-compressive locking plates as an independent predictor of non-union [12]. In our series, Case 2 was managed with a locking dynamic compression plate that allows axial compression and, in combination with bone grafting, achieved union at 18 weeks. Case 3 was treated with a non-locking narrow DCP; despite atrophic biology, union was obtained in 16 weeks, further supporting the superiority of plates capable of compression and the necessity of biological augmentation [13].

This small series adds to the growing evidence that meticulous surgical technique, autologous bone grafting and dynamic compression plating can achieve early union and excellent functional recovery in forearm non-union [14]. All patients in our series achieved union without complications and returned to pre-injury function. Limitations include the small sample and lack of long-term patient-reported outcomes; nevertheless, the findings reinforce current recommendations for compression plate osteosynthesis. Future research should clarify the indications for locking versus non-locking plates, explore biologic adjuvants such as bone morphogenetic proteins or platelet-rich plasma, and develop patient-specific risk stratification to tailor treatment [15]. Comparative studies examining emerging techniques like the Masquelet induced-membrane procedure, Ilizarov bone transport, and vascularized fibular grafts will further refine the management of complex forearm non-unions.

CONCLUSION:

Revision fixation using compression plate osteosynthesis combined with autologous bone grafting provides reliable union and excellent functional recovery in forearm non-union. Addressing both mechanical stability and biological insufficiency remains central to achieving predictable outcomes.

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