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CASE REPORT

Surgical Management of Gout-Complicated Humeral Nonunion: A Case Report

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ABSTRACT

Humeral shaft fractures may progress to nonunion despite operative management. We report a 50-year-old male with repeated surgical failure of a left humeral shaft fracture, found intraoperatively to have uric acid crystal deposition within the pseudoarthrosis site. The patient underwent implant removal, excision of the pseudoarthrosis, and rigid plate fixation augmented with an intramedullary fibular strut graft. At six months postoperatively, clinical evaluation demonstrated mechanical stability and satisfactory functional recovery. Although fibular strut grafting is not universally considered standard treatment for humeral nonunion, this case highlights its potential role in complex, biologically compromised nonunions associated with gout.

Keywords. humeral shaft fracture, nonunion, pseudoarthrosis, uric acid crystals, fibular strut graft, gout

INTRODUCTION

Nonunion of the humeral shaft remains a challenge in orthopedic practice. It is generally defined as failure of fracture healing after at least six months and occurs in approximately 10–23% of conservatively managed cases and 2–10% of cases treated with internal fixation.[1] Multiple factors contribute to nonunion and are broadly categorized as mechanical or biological. Mechanical causes include inadequate reduction or stabilization, whereas biological factors involve local tissue compromise, infection, and systemic conditions that impair bone healing.[1]

Systemic metabolic and endocrine disorders have increasingly been recognized as potential contributors to impaired fracture healing.[1] These include diabetes mellitus, thyroid and parathyroid disease, vitamin D deficiency, and other disorders affecting bone metabolism. However, definitive causal relationships remain difficult to establish, and many cases of nonunion continue to be attributed primarily to mechanical instability.

Gout is a common inflammatory condition characterized by hyperuricemia and deposition of monosodium urate crystals in joints and periarticular tissues.[2] Chronic gout may lead to bone erosion and, less commonly, intraosseous tophus formation.[2] Although gout has been reported in pathologic fractures, its role in fracture healing remains poorly understood.[3,4] Reported gout-associated fractures most frequently involve the femoral neck and patella, with limited literature describing long-bone involvement.[3,4]

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To our knowledge, reports describing uric acid crystal deposition within a humeral shaft pseudoarthrosis are exceedingly rare. This case highlights an unusual presentation of humeral nonunion complicated by urate crystal deposition and explores the possible role of gout as a biological factor affecting fracture healing.

CASE

Our patient was a 50-year-old right-handed Filipino male from Pangasinan. Five years before admission, he was involved in a motor vehicle accident that resulted in a left humeral shaft fracture. He underwent open reduction and internal fixation with plate application at a private hospital. The patient reported that wrist drop began after the first surgery and persisted thereafter. Four years before admission, he developed recurrent left arm pain, and evaluation revealed implant failure. He subsequently underwent hardware removal and intramedullary nailing of the humerus with iliac crest bone grafting at another institution. Following this procedure, he regained functional use of the arm and was able to perform household activities.

Two years before admission, he sustained another injury after falling from standing height and striking his left arm directly against a concrete surface. He subsequently noted progressive deformity and pain but did not seek immediate medical consultation. Although the pain gradually subsided, he continued to experience subjective instability of the arm. Later evaluation in our clinic demonstrated humeral instability with radiographic findings consistent with nonunion. Definitive surgery was recommended.

His family history was unremarkable. He had been previously diagnosed with gout prior to admission; however, the exact duration of disease, maintenance medications, and treatment compliance could not be reliably ascertained from the available history. He reported a five-year history of cigarette smoking at approximately one pack per day, which he discontinued after his injury, although he continued to have exposure to second-hand smoke.

He was a moderately built male with multiple firm subcutaneous nodules over the periarticular regions of both upper and lower extremities, clinically consistent with chronic tophaceous gout (Figure 1). The left arm demonstrated gross deformity with a well-healed anterolateral surgical scar. Abnormal motion at the mid-shaft of the humerus was elicited on gentle manipulation, independent of elbow and shoulder movement, consistent with pseudoarthrosis. A wrist drop was present, indicating radial nerve palsy. Bilateral iliac crest surgical scars, approximately 5 cm in length, corresponded to prior bone graft harvest sites. The Disabilities of the Arm, Shoulder and Hand (DASH) score was 68.3/100, indicating significant functional limitation.

Baseline laboratory investigations revealed serum electrolytes within normal reference ranges (Na 137.3 mmol/L, K 3.81 mmol/L, Cl 101.1 mmol/L, ionized Ca 1.28 mmol/L). White blood cell count was mildly elevated at 11.98 $\times 10^9$/L with neutrophil predominance. Hemoglobin and platelet counts were within normal limits. Procalcitonin was <0.10 ng/mL, not suggestive of bacterial sepsis. C-reactive protein was 6.61 mg/L (within laboratory reference range), whereas erythrocyte sedimentation rate was elevated at 70 mm/hr. Serum uric acid was elevated at 10.3 mg/dL, consistent with active hyperuricemia. Renal function, fasting glucose, and lipid profile were within acceptable limits.

Radiographs of the left humerus showed a displaced midshaft fracture, with significant gapping and no signs of callus formation. There was an intramedullary nail, broken at the level of the distal locking screw hole, with "wiper" sign noted at this level (Figure 2).

The patient was co-managed with internal medicine for metabolic evaluation and optimization of hyperuricemia.

The admitting diagnosis was implant failure of the left humerus secondary to aseptic nonunion with radial nerve palsy, in the setting of chronic tophaceous gout.

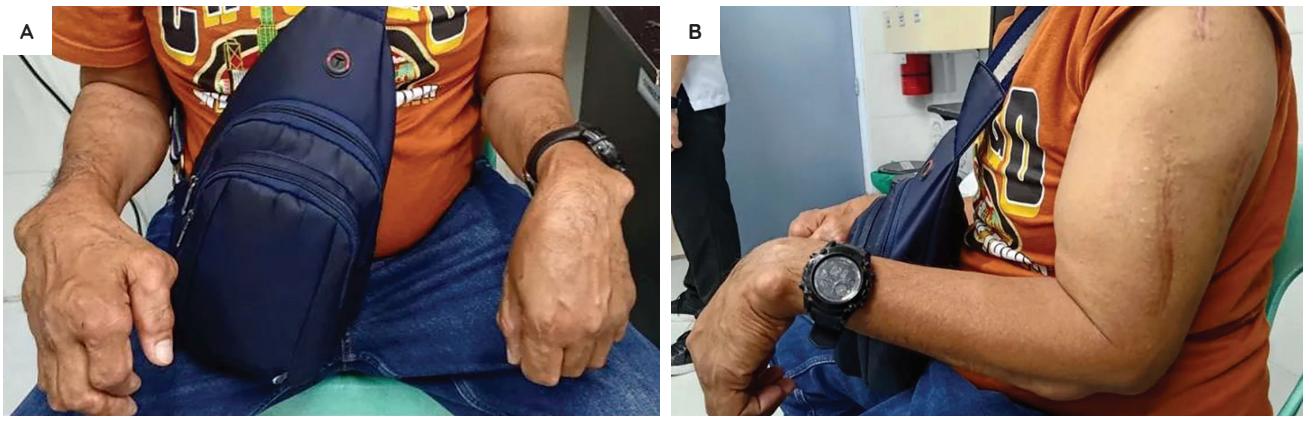

Figure 1. Clinical photographs demonstrating tophaceous gout. Anterior view of the upper extremities showing multiple subcutaneous nodular deposits consistent with tophaceous gout **(A)**. Lateral view of the left arm demonstrating periarticular tophaceous enlargement and soft tissue thickening along the upper extremity **(B)**.

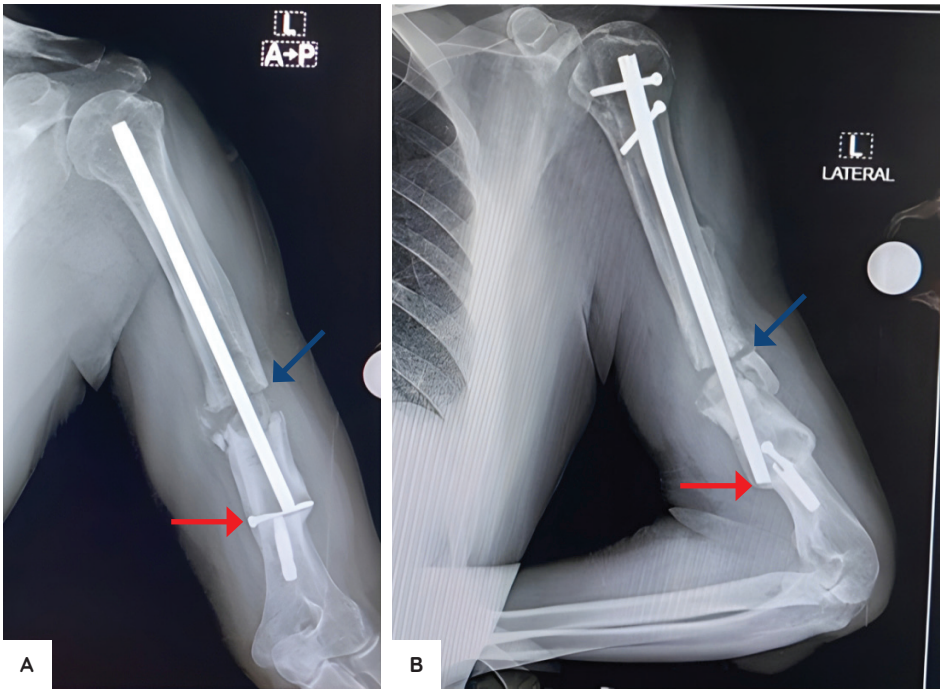

Figure 2. Anteroposterior **(A)** and lateral **(B)** radiographs of the left humerus demonstrating implant failure, with breakage of the intramedullary nail at the distal locking screw hole *(red arrow)*, persistent fracture gap at the midshaft nonunion site *(blue arrow)*, and a healed distal fracture segment.

Figure 3. Our template for the Open reduction internal fixation (locking plate) with intramedullary fibular strut graft shown in AP **(A)** and lateral **(B)** view.

Figure 4. Pseudoarthrosis site and visible metallosis.

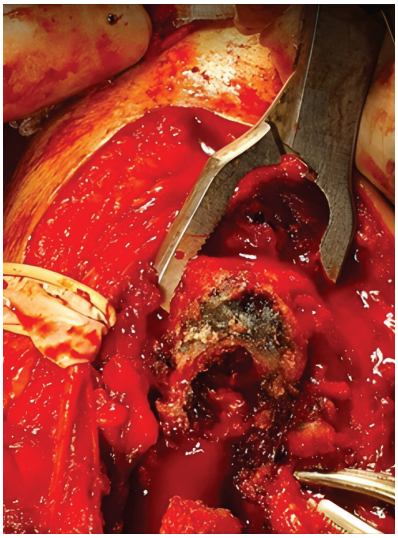

Figure 5. Intraosseous uric acid deposition with white chalky paste-like tissue.

Definitive surgical management consisted of implant removal, excision of the pseudoarthrosis, and open reduction and internal fixation using a locking plate augmented with an intramedullary fibular strut graft (Figure 3).

The humerus was approached posteriorly. Pseudoarthrosis was confirmed intraoperatively by the presence of pathologic motion, fibrous tissue with synovial characteristics lining the nonunion cavity, and absence of osseous continuity between fracture fragments. Metallosis was also observed within the pseudoarthrosis cavity, supporting the chronicity of the nonunion and prior implant breakdown (Figure 4). Dissection of the capsule after removal of the intramedullary nail revealed uric acid crystals, which appeared as white chalky pasty deposits. Intraosseous deposition was also noted with the white chalky paste-like tissue on both proximal and distal ends of the fracture (Figure 5).

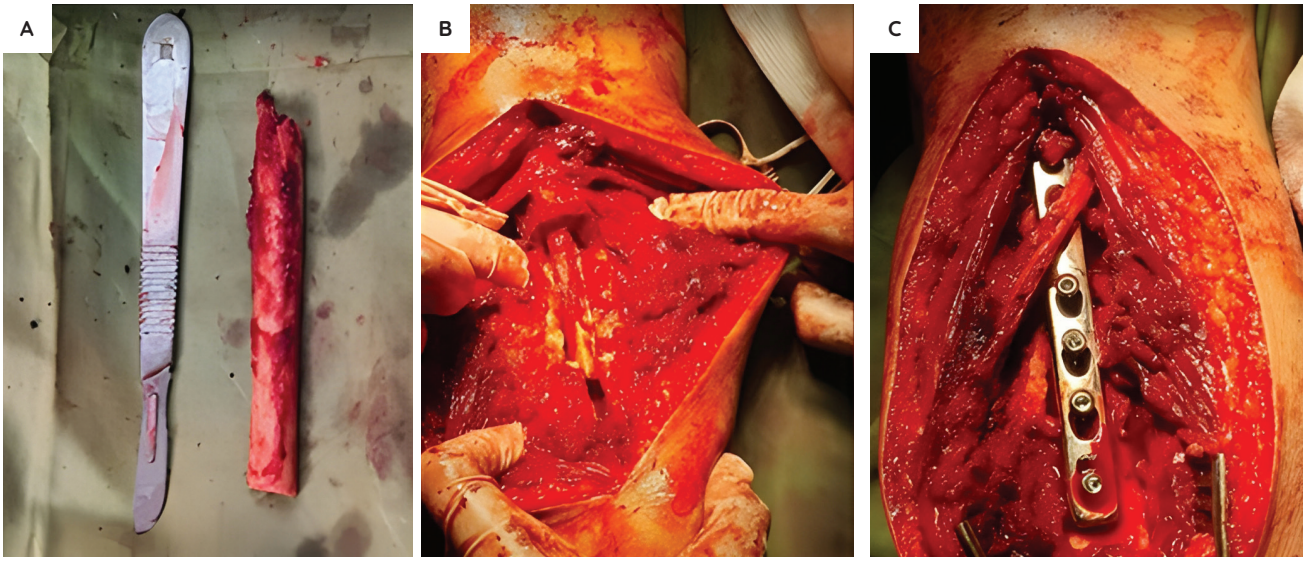

Figure 6. Definitive fixation with fibular strut graft and plate. Non-vascularized fibular strut graft fashioned on the back table (around 8 cm) prior to insertion **(A)**. Strut graft shown press-fit to the intramedullary canal **(B)**. Final construct showing a press-fit fibular strut within the medullary canal bridged by a locking plate; the radial nerve was identified and preserved **(C)**.

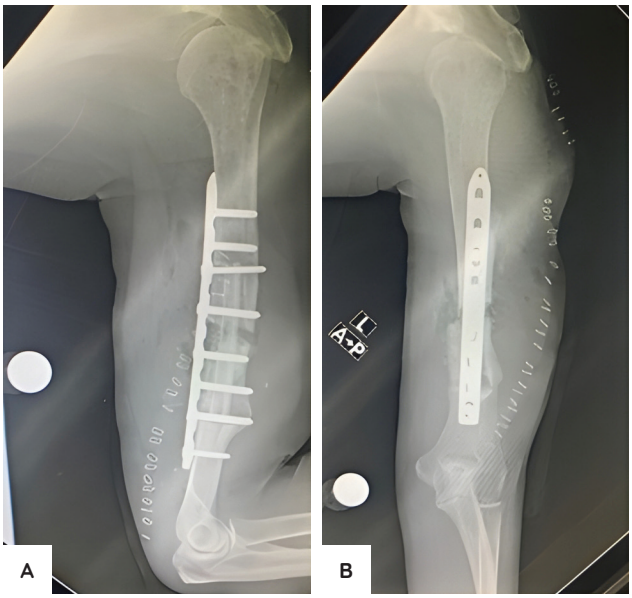

Figure 7. Postoperative x-rays of the left humerus in anteroposterior **(A)** and lateral **(B)** views, showing stable fixation of the fracture segments with an intramedullary strut graft bridging the fracture gap.

A non-vascularized fibular strut graft (8 cm long) was harvested and fashioned, and press-fit into the intramedullary canal, spanning the fracture site (Figure 6). A locking plate was applied, spanning the graft and fracture site (Figure 7). The radial nerve was identified intact and was preserved throughout the procedure (Figure 6).

The patient was discharged on oral medications with instructions for early range-of-motion exercises. The final diagnosis was implant failure of the left humerus secondary to aseptic nonunion with pseudoarthrosis and uric crystal deposition, in a patient with gouty arthritis.

Six months postoperatively, the patient reported no pain. The surgical incision was well-healed without signs of infection. There was no tenderness over the fracture site, and no motion at the mid-shaft of the humerus, indicating mechanical stability.

He was able to do active elbow flexion and extension, and wrist and finger extension, consistent with recovery of radial nerve function. The patient was able to perform activities of daily living independently without significant limitation.

Follow-up radiographs were not obtained at six months; therefore, radiographic union could not be objectively confirmed. Nonetheless, clinical findings were consistent with stable fixation and satisfactory functional recovery at the time of last follow-up.

DISCUSSION

A literature search using the keywords "nonunion," "tophi," "gout," "fractures," "long bone fractures," and "pseudoarthrosis" did not reveal any similar reported cases, suggesting that this presentation is rare and further supporting our decision to report this case.

Pseudoarthrosis refers to a chronic nonunion in which a false joint forms at the fracture site, characterized by fibrous tissue interposition, abnormal mobility, and often a synovial-like lining between bone ends. Metallosis is the pathological accumulation of metallic debris in surrounding soft tissues, resulting from implant wear, corrosion, or mechanical failure. It is seen grossly as dark gray to black discoloration of tissues and is commonly associated with chronic implant failure.

Treatment of humeral shaft nonunion focuses on restoring mechanical stability and optimizing the biological environment for healing, typically through rigid internal

Figure 8. Six-month postoperative clinical follow-up. Anterior view of the patient at rest demonstrating healed surgical incision and symmetric resting position of both upper extremities **(A)**. Lateral view of the left arm showing restoration of arm contour **(B)**. Active elbow flexion and forearm positioning demonstrating functional elbow motion without evidence of instability **(C)**. Active wrist and finger extension indicating recovery of radial nerve function **(D)**.

fixation—most commonly compression plating—with bone graft augmentation when indicated.[1] In complex or recalcitrant cases, particularly those with compromised bone stock, widened medullary canals, segmental bone loss, or prior implant failure, intramedullary fibular strut graft augmentation has been described as a valuable adjunct.[5,6] The fibular strut provides structural support, increases construct stiffness, and serves as a biological scaffold. Although not universally considered standard for all humeral nonunions, literature supports its use in difficult cases with mechanical and biological compromise.[5,6]

In our patient, fracture healing failed after two prior surgeries. Intraoperative findings demonstrated chalky deposits consistent with urate crystal deposition within the pseudoarthrosis. Chronic gout is characterized by monosodium urate crystal deposition and persistent inflammation, which may promote osteoclastic activity, bone erosion, and altered remodeling.[2] While gout as a systemic diagnosis has not consistently been shown to increase overall fracture risk at the population level,[7] intraosseous tophi represent a subset in which localized crystal deposition may compromise structural integrity and predispose to pathological fracture or impaired healing.[2-4] These observations raise the possibility that urate deposition at the nonunion site contributed to a biologically unfavorable environment for fracture repair, particularly when combined with mechanical instability from repeated implant failure.

The stability problem in this case was multifactorial. Recurrent implant failure and persistent abnormal motion at the fracture site suggested inadequate mechanical control. Intraoperative findings of pseudoarthrosis further indicated long-standing instability. Such conditions reduce interfragmentary compression and allow continued motion that inhibits bridging callus formation.[1] Definitive management, therefore, required both meticulous debridement of fibrous tissue and robust fixation capable of controlling rotational and bending stresses across the nonunion site.

Among available literature, the study by Barnes et al. is particularly relevant, as it specifically evaluated humeral shaft nonunions treated with nonvascularized fibular strut allograft augmentation.[5] Their technique demonstrated favorable union rates and functional outcomes in difficult humeral nonunions by improving fixation purchase and structural rigidity while maintaining plate stability.[5] This approach parallels our management strategy, wherein an intramedullary fibular strut graft was used to augment plate fixation in a multiply operated humeral shaft nonunion with compromised biology.

In contrast, Yadav et al. described the fibular strut as a "biological intramedullary nail" for complex long-bone nonunions, emphasizing its mechanical advantages and technical considerations.[6] These studies did not specifically address nonunions related to gout or urate deposition; however, they support the principle that structural augmentation

can improve stability and facilitate healing in challenging cases.[6] In our patient, this principle was applied in the context of suspected gout-complicated nonunion, where both mechanical insufficiency and potential biological impairment likely contributed to healing failure.

This case underscores the importance of a multidisciplinary approach in patients with chronic gout undergoing surgical management for nonunion. Metabolic evaluation and optimization of hyperuricemia should accompany definitive mechanical stabilization. While causality cannot be definitively established from a single case, the presence of urate deposition at the pseudoarthrosis highlights a potential biological factor that merits further investigation.

CONCLUSION

Intraosseous uric acid crystal deposition may predispose to fracture and potentially contribute to impaired healing and nonunion. Surgical management in such cases should be accompanied by appropriate metabolic optimization to address the underlying hyperuricemic state. In the present case, augmentation with a fibular strut graft was selected, considering the patient's history of repeated fracture healing failure and persistent mechanical instability. This approach resulted in improved clinical stability, resolution of pain, and satisfactory functional recovery at six months postoperatively.

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The Department of Orthopedics at Region 1 Medical Center is provisionally accredited by the Philippine Board of Orthopedics. The department remains committed to continually striving to provide optimal quality care for its patients.

ETHICAL CONSIDERATIONS

Patient consent form was obtained before manuscript submission.

STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

CREDIT AUTHOR STATEMENT

NKPP: Conceptualization, Methodology, Software, Validation, Investigation, Resources, Data Curation, Writing – original draft preparation, Writing – review and editing, Visualization, Project administration, Funding acquisition; **MCC:** Conceptualization, Supervision.

DATA AVAILABILITY STATEMENT

No datasets were generated or analyzed for this research.

AUTHOR DISCLOSURE

The authors declared no conflict of interest.

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