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Proximal humerus variable angle locking plate for the treatment of periprosthetic humeral fractures in a patient with previous tendon transfers: a case report

Rodrigo de Marinis, MD[a,b,*], Cristóbal López, MD[a], Christina Regan, BS[c], Sergio F. Guarin Perez, MD[c], Alfonso Valenzuela, MD[a], Gonzalo Kameid, MD[b], Rodrigo Liendo, MD[a]

[a]Department of Orthopedic Surgery, Pontificia Universidad Católica de Chile, Santiago, Chile
[b]Shoulder and Elbow Unit, Hospital Dr. Sótero del Río, Santiago, Chile
[c]Department of Orthopedic Surgery, Mayo Clinic, Rochester, MN, USA

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Reverse Shoulder Arthroplasty (RSA) is the treatment of choice for a growing number of conditions, including fractures and rotator cuff deficiency.[6,16] Despite growing popularity, RSA complication rates range from 19%-68%.[12] Common complications include scapular notching, baseplate failure, scapular and acromial stress fractures, instability, and component dissociation.[2] While relatively uncommon at a complication rate of 0.5% to 3%, periprosthetic humerus fractures (PHFs) can be devastating.[11] PHFs can occur intraoperative (59%) or postoperatively (41%).[4] Intraoperative humerus fractures are most likely to occur during the preparation of the humeral canal stem impaction,[14] while postoperative humerus fractures are most common after a traumatic event.[18]

PHFs can be classified based on several characteristics. According to the Unified Classification System,[8] they can be categorized based on the location of the fracture in relation to the implant: fracture of the tuberosities (Type I), peri-implant (Type II), or distal to the implant (Type III). Depending on the location, fractures can be further subcategorized by fixation of the stem (loose or fixed) and quality of bone stock (adequate or inadequate).[8,9] To help guide management, Sanchez-Sotelo, and Athwal recently expanded on the Unified Classification System and provided a treatment algorithm for each fracture subcategory.[18] If the humeral implant is well fixed after the fracture, treatment options depend on the degree of displacement and include conservative management, open reduction and internal fixation (ORIF), or revision of the humeral component.[13,18] For fractures near the tip of the stem with a stable humeral component, nonsurgical treatment with a brace has been reported; however, nonunion rates can be as high as 50%.[9] As a result, the use of plates has become more frequent, and recent literature indicates a higher union rate than conservative management.[9,17] The surgical technique for PHF fixation is mainly described in clinical series and case reports describing straight plates and cables.[7,21] In the humerus, cables require extensive detachment of surrounding soft tissues to avoid iatrogenic damage to the radial nerve. Moreover, cadaveric studies have shown that cables provide significantly lower fixation strength in torsion, axial compression, and lateral loading.[15] Using proximal humerus plates in PHF may allow for a less invasive treatment, providing a solid fixation and possibly decreased operative times. This article presents a case report of a PHF in a patient with associated tendon transfers who was successfully treated with a proximal humerus variable angle locking plate. We emphasize the technical aspects needed to achieve a stable fracture fixation without cables, thus avoiding extensive soft tissue release.

The ethics committee of Pontificia Universidad Catolica de Chile approved this study, IRB number: 220928003.

*Corresponding author: Rodrigo de Marinis, MD, Department of Orthopedic Surgery, Pontificia Universidad Católica de Chile, Diagonal Paraguay 362, 3er piso, Región Metropolitana, Santiago 8330077, Chile.
E-mail address: ridemarinis@uc.cl (R. de Marinis).

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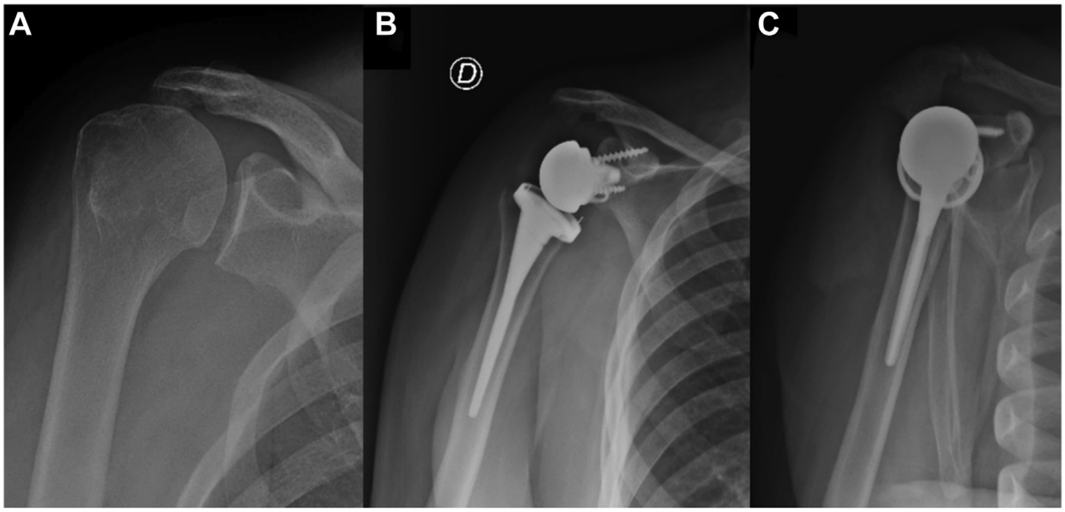

Figure 1 Preoperative radiograph before Reverse Shoulder Arthroplasty (**A**) and postoperative radiographs (**B** and **C**).

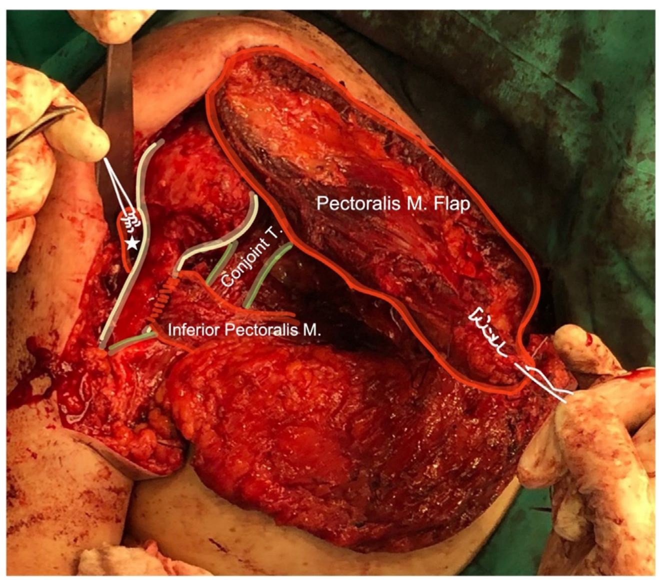

Figure 2 Intraoperative image of a combined pedicled pectoralis major transfer and latissimus dorsi transfer in a previously failed reverse shoulder arthroplasty patient. The surgeon holds the distal end of both transfers (latissimus dorsi is marked with a white star). The capsule was kept intact during this procedure to avoid unnecessary implant exposure.

Case report

A 68-year-old obese male patient presented with a history of longstanding right shoulder pain and imaging consistent with cuff tear arthropathy. RSA was performed without any noted intraoperative complications. Preoperative and postoperative radiographs are shown in Figure 1. After eight months, the patient reported severe pain (8/10), lack of active elevation, and complete loss of the external rotation (ER). Electromyography revealed a complete transection of the axillary nerve. A computed tomography (CT) confirmed a well-positioned RSA and severe deltoid muscle wasting. After discussing treatment alternatives with the patient, a pedicled pectoralis major transfer, as described by Burkhard et al[5] was planned to restore elevation, and a concomitant latissimus dorsi transfer was performed to restore ER control (Fig. 2). At one year follow-up, the patient regained partial function and was very satisfied with a QuickDASH score of 18.5 and a Shoulder Subjective Value of 50%. Physical examination revealed a negative ER lag sign, 75° of forward flexion, 15° of external and internal rotation (IR) to L1. Unfortunately, a week after this visit, the patient fell onto his right shoulder and presented to the emergency department with a periprosthetic fracture. Radiographs at this time demonstrated a PHF located at the tip of the stem (Type IIA), as shown in Figure 3. Of note, a cortical button that was used during the prior pectoralis major transfer was placed immediately distal to the tip (a stress raiser zone) and may have contributed to the presentation of this fracture. A CT scan was ordered to evaluate implant position further, and the fracture pattern revealed a well-positioned glenoid component and a humeral stem without signs of loosening (Fig. 4). Surgical treatment was advised based on the fracture pattern (short-oblique/transverse at the tip of the

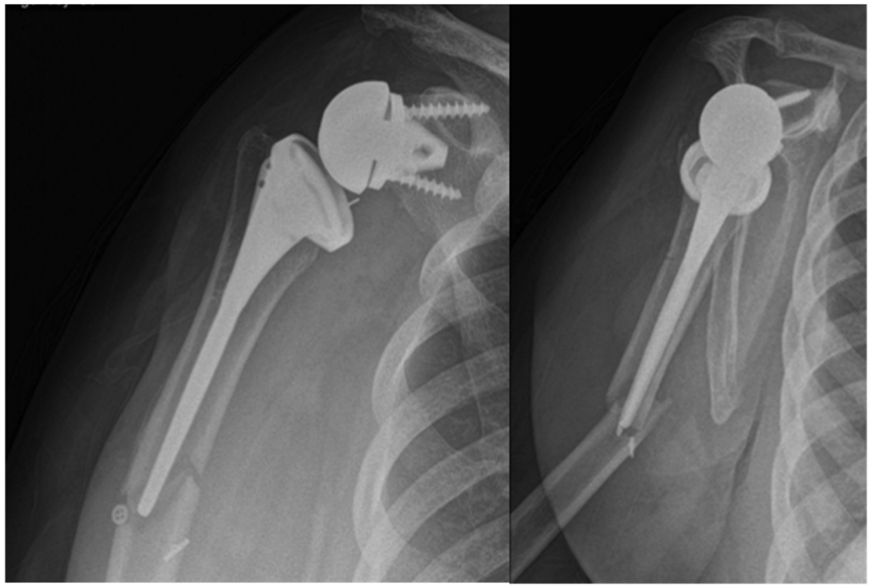

Figure 3 X-rays showing a periprosthetic humerus fracture at the tip of the stem.

well-fixed humeral stem) in the setting of previously functional tendon transfers fixed at the proximal fragment (latissimus dorsi) and the distal segment (Pectoralis major). We planned an ORIF using a proximal humerus plate with variable angle locking screws to avoid the use of cables and minimize soft tissue releases. The presence of a relatively thin stem (8 mm) and adequate proximal bone stock allows for the placement of multiple proximal screws that may provide stable fixation. The patient's consent was obtained to publish his case, related information, and images.

Periprosthetic fracture surgical technique

After general anesthesia, the patient was placed in the beach chair position. An incision was made on the distal area of the previous deltopectoral approach, with an anterolateral extension to the middle third of the arm. Surgical dissection was performed up to the humeral shaft, preserving the insertions of the major pectoralis major and latissimus dorsi transfers. The fracture site was débrided, and reduction was performed with reduction clamps. After reduction was confirmed and held in place, an anatomic proximal humerus low plate (A.L.P.S Proximal Humerus Plating System, Zimmer Biomet, Warsaw, IN, USA) was placed. Proximal fixation was achieved with two cortical screws and five divergent locking screws. The distal segment was fixed with a cortical screw and three locked screws achieving excellent stability. The final construct had the plate positioned approximately five centimeters distal to the greater humeral tuberosity, avoiding excessive muscular detachment and leaving the zone of insertion of the previous latissimus dorsi transfer intact (Fig. 5).

Postoperatively, the patient was placed on a shoulder sling, allowing pendulum exercises and passive range of motion (ROM) as tolerated from the day. Supervised rehabilitation started at three weeks, focusing on passive glenohumeral ROM and periscapular strengthening. At six weeks, active and surface electromyography-guided exercises were utilized to regain control over the pectoralis major and latissimus dorsi transfers and continued for the next three months.

Outcome

At 18 months follow-up from the ORIF (30 months after tendon transfers), the patient had regained function and had no pain at rest or during activity. Clinical evaluation revealed a QuickDASH score of 18.1, a Shoulder Subjective Value of 50%, and a pain score of 1/10 with activities and no pain at rest. ROM improved with complete regain of ER (15°) and IR (L1) compared to the prefracture status. Forward flexion improved (60°) but was lower than the prefracture ROM (75°). Figure 6 demonstrates the ROM at final follow-up. Overall, the patient had a stable, functional extremity that allowed him to do all basic daily life activities. Radiologically, the patient showed signs of consolidation starting at postoperative week three and had a completely healed fracture at final follow-up 26 months post-ORIF (Fig. 7).

Discussion

In this case report, we presented a periprosthetic fracture in a patient with previous RSA and tendon transfers that was successfully treated with the use of a variable angle long locking plate designed for the proximal humerus. This treatment option allowed for an early ROM, stable fixation, and restoration of function.

In PHF, assessing the humeral component fixation is crucial in determining the best treatment option. In uncemented humeral stems, the presence of a radiolucent line measuring >2 mm in shoulder radiographs in three or more zones around the perimeter of the stem has been described as a reliable indicator of loosening.[19] In patients with well-fixed implants, there is no defined gold standard of treatment. As a result, patient risk factors (rheumatoid arthritis, revision surgery, female gender, osteopenia) and fracture patterns are used to determine the best course of action.[1,18] Conservative treatment has been traditionally proposed for fractures with a well-fixed humeral component. The degree of displacement and rotation tolerated in these cases is not clearly established, and usually, similar criteria to those used for simple diaphyseal humerus fractures are adopted.[10,14] However, several case series report high nonunion and delayed union rates.[14,22] In the presented case, the presence of hardware (a cortical button) at the fracture site and the fracture pattern (short oblique) in an obese patient were considered risk

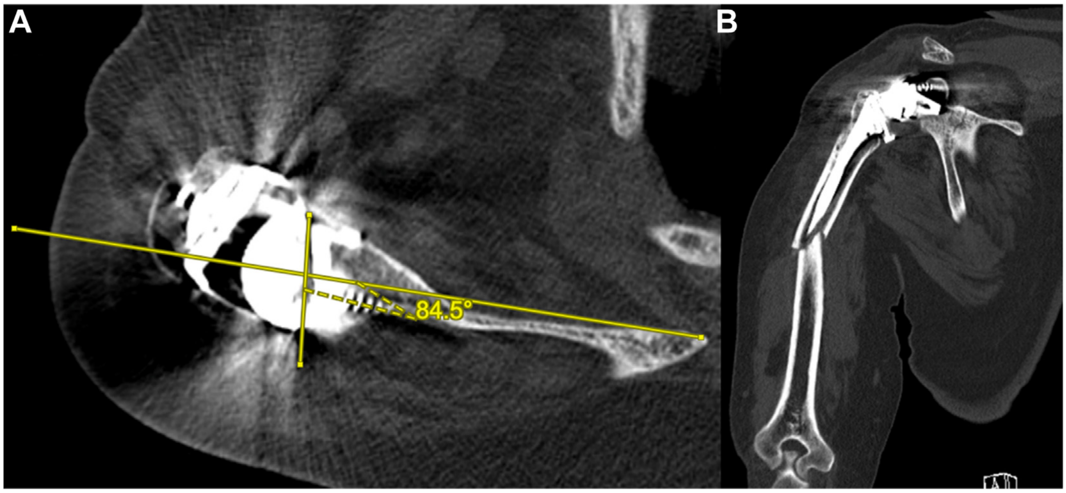

Figure 4 Computed Tomography confirming a well-positioned glenoid component and a periprosthetic fracture at the tip of the stem (Type IIA).

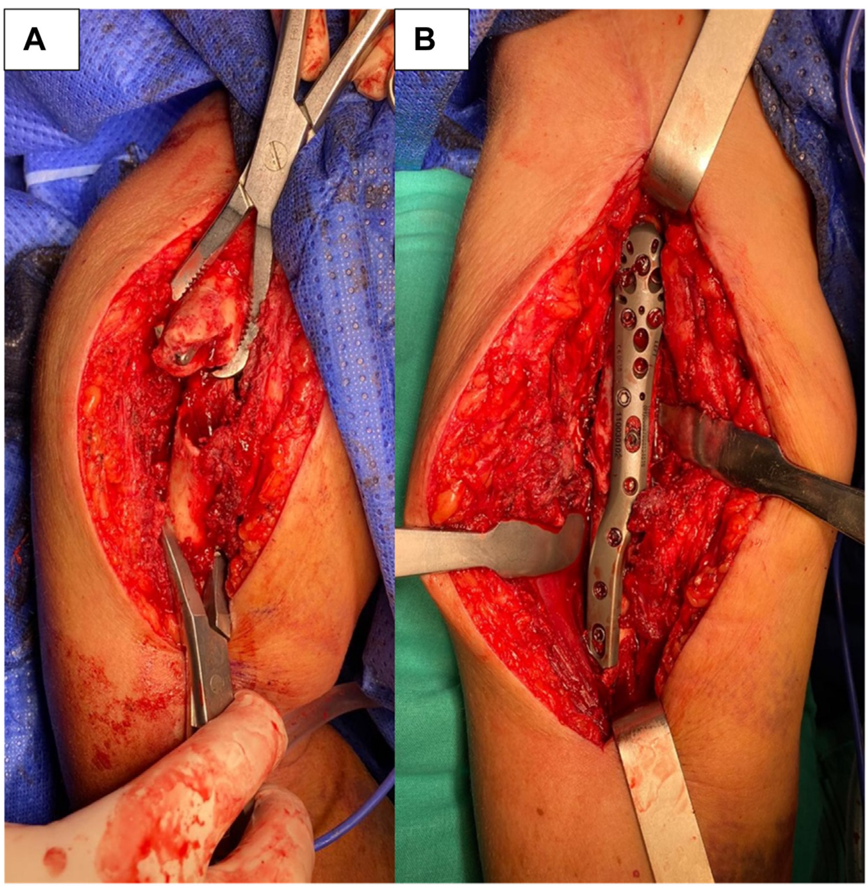

Figure 5 Intraoperative aspect of the fracture through an anterolateral approach with the tip of the stem in the proximal fragment (**A**) and then reduced with a proximal humerus long plate (**B**).

factors for failure of conservative management. Furthermore, the morbidity associated with a prolonged immobilization period could have been especially detrimental as the latissimus dorsi and pectoralis major were previously transferred and adequately retrained to provide elevation and external rotation to the shoulder.

Once we decided to treat this case surgically, the goals were to 1) limit soft tissue release, 2) provide a stable fixation, and 3) allow for an early ROM. Cable or wire cerclage typically requires circumferential soft tissue release from bone, and this is especially important in the humerus to expose and protect the radial nerve. While cables have been successfully used to treat periprosthetic fractures, they provide inferior biomechanical strength compared to screws in this setting.[15] Proximal humerus plates with variable locking angle screws provide stable fixation and offer several

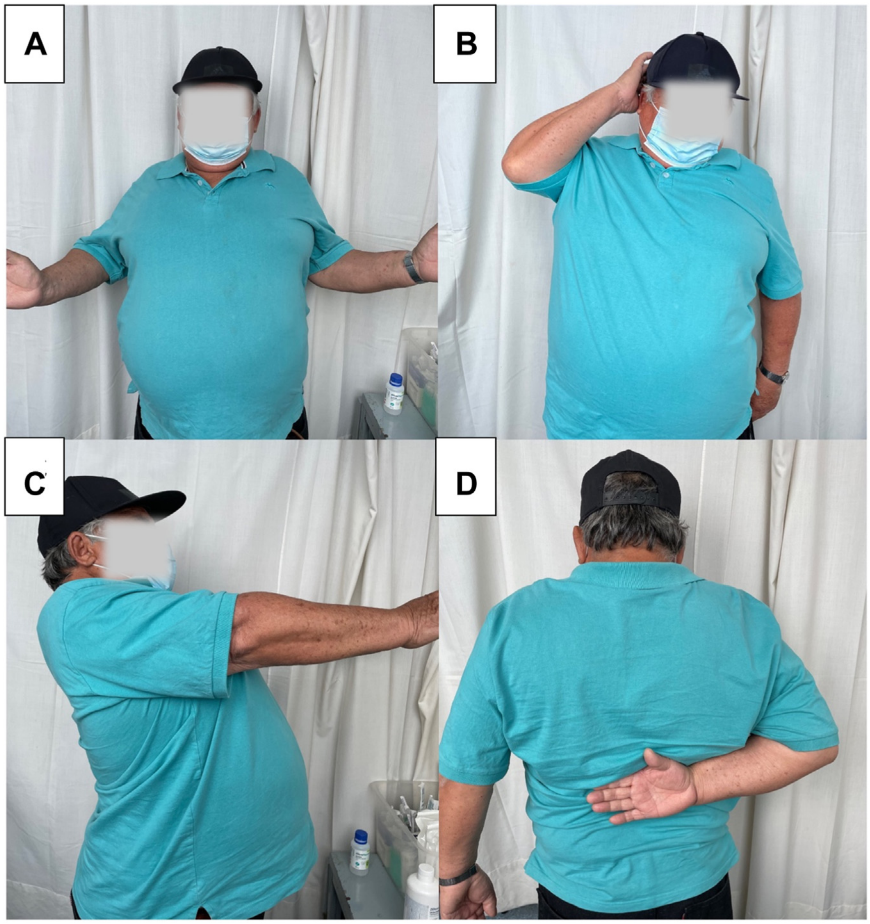

Figure 6 Range of motion at 18 months follow-up from the ORIF (30 months after tendon transfers) (**A**) external rotation 20° (**B**) Negative "horn-blower" sign, patient can perform external rotation in abduction (**C**) shoulder elevation 80° (**D**) internal rotation T10. *ORIF*, open reduction and internal fixation.

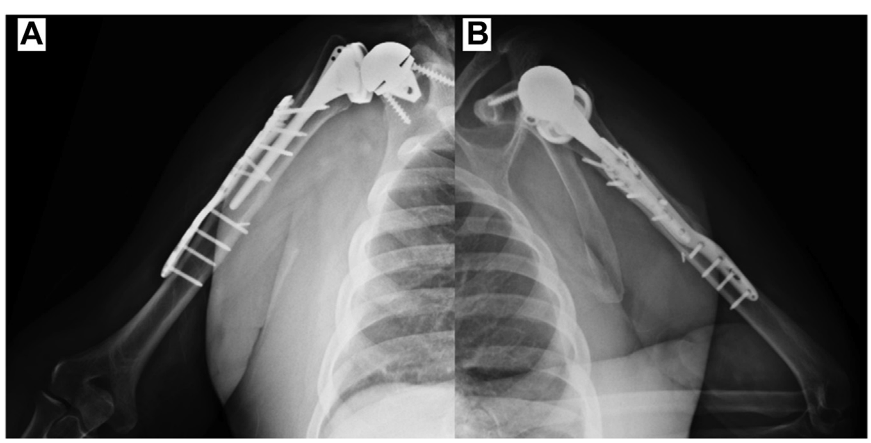

Figure 7 Final follow-up x-rays with advanced consolidation in both anteroposterior (**A**) and lateral (**B**) views.

advantages in the surgical management of PHF. Variable locking allows for a 20°-25° cone angle for the multidirectional locking screws, thus avoiding contact with the humeral component (Fig. 8) while achieving adequate fixation to bone. The plate system used in this case has a diaphyseal extension that rotates anteriorly, which allows the plate to be placed, avoiding the deltoid insertion; this also minimizes the risk of radial nerve injury laterally and distally. Additionally, decreasing the amount of periosteal release has been shown to enhance healing and prevent overall complications.[3,20] Nonetheless, if a stable screw fixation cannot be achieved, especially in a well-fixed long stem setting, cable cerclage is an adequate alternative and should be considered for such cases. A limitation of the presented technique is that thick humeral stems implanted in osteoporotic bone with thin cortices may not leave enough space for screw placement. A CT scan may also be used during preoperative planning to confirm that enough

Figure 8 Proximal humerus plate. The Blue dotted line shows the plate lying distal to the stem Top, which allows for better screw positioning.

bone is available for screw fixation and to decide the best implant configuration.

Conclusion

In this case report, a variable angle proximal humerus plate provided stable fixation without using cerclage cables or wires in the setting of a PHF. This technique allowed for reduced surgical invasion, early ROM, and regaining of function without complications in a patient with previous tendon transfers and a well-fixed humeral component.

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