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Combined RTSA with interlocking stem and plate for proximal metadiaphyseal humeral fractures: a report of two cases

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Proximal humerus fractures are the third most common osteoporotic fracture,[9] occurring in women more frequently than men, with a peak in incidence in patients 60-90 years old. While many of these injuries can be managed nonoperatively, multiple surgical options exist, including locked plating (LP), intramedullary nailing (IMN), and reconstruction arthroplasty. While LP and IMN have high rates of success in terms of restoring motion and function,[9] implant complications may necessitate revision surgery due to implant failure. For example, screw penetration into the glenohumeral joint is the third most common complication associated with LP, comprising up to 8% of all complications associated with this technique.[11] Implant-related complications are observed less frequently with IMN compared to LP,[4] but reoperation rates can still be as high as 13%, 17%, and 63% for 2-, 3-, and 4-part fractures, respectively.[14] Reconstruction is typically reserved for patients with compromised rotator cuff integrity, osteoarthritis, and/or humeral head defect.

For patients with concomitant humeral head defects and proximal bone loss, isolated fixation and can be challenging as neither LP nor IMN can address humeral head pathology. A recent study comparing LP (n = 24) to reverse total shoulder arthroplasty (RTSA; n = 4) for head split fractures, showed higher revision (24% vs. 0%) and complication rates for LP,[8] mostly related to osteonecrosis (42%), lesser tuberosity nonunion (33%), and screw penetration (29%). Arthroplasty can also be challenging due to concerns for inadequate humeral fixation. For example, in the setting of metastatic tumors with proximal humerus bone loss, while RTSA is an acceptable option, bone loss may lead to instability and loosening.[1] Long-stemmed humeral components may be used to bypass poor proximal bone with good results;[5] however, fixation may be inadequate in the setting of an associated humeral shaft fracture. In this 2-patient case series, we report a novel construct using a reverse total shoulder stem interlocked into a lateral compression plate. This technique offers surgeons a viable option for treating humeral head pathology acutely in the setting of a concomitant humeral shaft fracture or for revision surgeries due to nonunion. Both patients consented to the presentation of their cases.

Case report

We present 2 patients who underwent RTSA with a stem interlocked into a locking 4.5 mm plate. The first patient, an 85-year-old female with history significant for diabetes,

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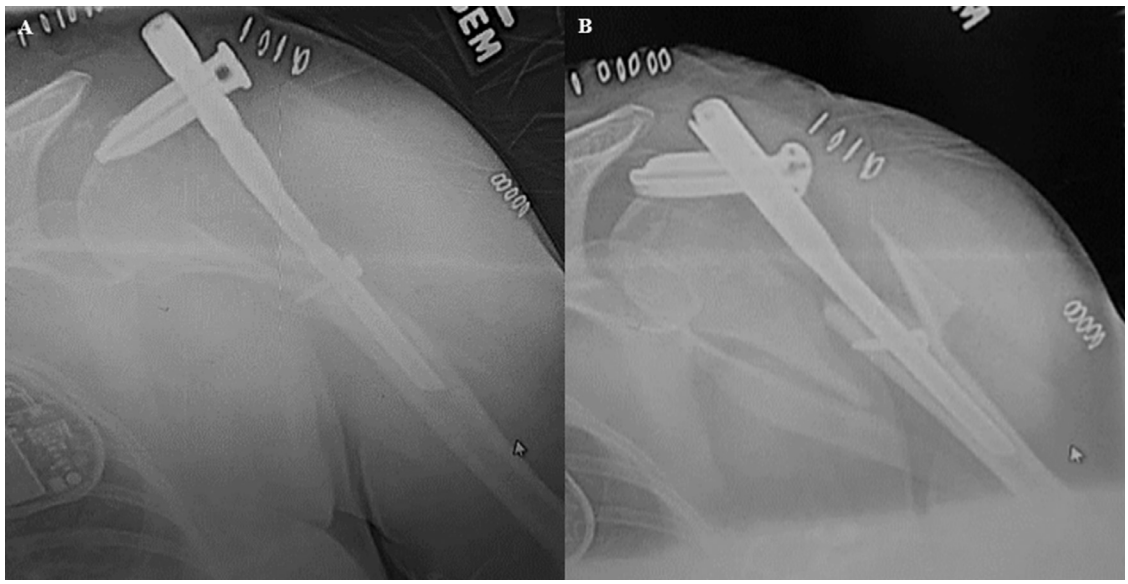

Figure 1 – Preoperative radiographs of an 85-year-old female showing a comminuted left proximal humerus fracture. The patient had implant failure of a prior intramedullary rod placed with helical blade cut out. (A) Anteroposterior and (B) internal rotation views.

pacemaker placement for arrhythmia, syncope, underwent a humeral nail at an outside hospital for a comminuted proximal third humeral shaft fracture sustained during a fall. Two weeks following her index surgery, she felt a pop in her shoulder while performing range of motion exercises during physical therapy prompting evaluation in our clinic. Imaging revealed cutout of the helical blade with destruction of the anterior greater tuberosity (Fig. 1). The second patient, a 72-year-old female with history of diabetes and stage IV chronic kidney disease, sustained a 3-part proximal humerus fracture that extended into the proximal third of the humeral shaft after a fall (Fig. 2). Her humerus was also anteriorly subluxed with an anterior glenoid rim fracture that required closed reduction. Given the first patient's tuberosity injury and

Figure 2 – Preoperative radiographs of a 72-year-old female showing a comminuted left metadiaphyseal proximal humerus fracture. (B) Anteroposterior and (B) axillary views.

humeral head cutout and the second patient's instability with tuberosity comminution, we recommended RTSA in lieu of plate fixation or anatomic shoulder replacement. Aside from initial nail extraction in the first patient, the surgical approach and sequence were similar.

A standard deltopectoral approach was used. Multiple traction sutures were placed in the rotator cuff tendons. The subscapularis was left attached to the lesser tuberosity, which was osteotomized in the patient with nail cut out. Following standard glenoid exposure and preparation, the base plate was secured with locking screws. Provisional reduction of the humerus was performed. A press fit humeral stem (Fx Solutions, Dallas, TX, USA; Humerlock II cementless stem with two interlocking screw holes) was then placed. An attempt was made to use a sufficiently sized stem to obtain some form of friction fit distally in the intact humeral diaphysis. A 4.5 mm compression plate (Synthes, West Chester, PA, USA; 4.5 mm LCP narrow plate, 9 hole) was placed to bridge the distal extent of the fracture (Fig. 3, *A*). An external aiming arm was attached to the stem and was used to position the plate so that 2 interlocking screws could be placed through the plate into the stem (Fig. 3, *B*). Three bicortical screws were secured distally in the plate (Fig. 3, *C*). Fixation proximally was supplemented with a cerclage cable and unicortical locking screws as needed for stability (Fig. 3, *D*). The fracture reduction and stem placement were confirmed with fluoroscopy. The tuberosity fragments were then repaired to the prosthesis using heavy #5 suture (Figs. 4 and 5). The humeral polyethylene spacer was built up as needed to obtain appropriate soft tissue tension for the arthroplasty.

Figure 3 – Intraoperative fluoroscopy of a reverse total shoulder prosthesis interlocked with a locking compression plate. (A) The humeral stem is seated in place and the locking plate provisionally fixed, (B) 2 interlocking screws are placed through the plate and stem as guided by the aiming arm (seen in lateral area of image), (C) 3 distal bicortical screws are fixed distally, and (D) additional stem-to-plate fixation is achieved with a cerclage wire.

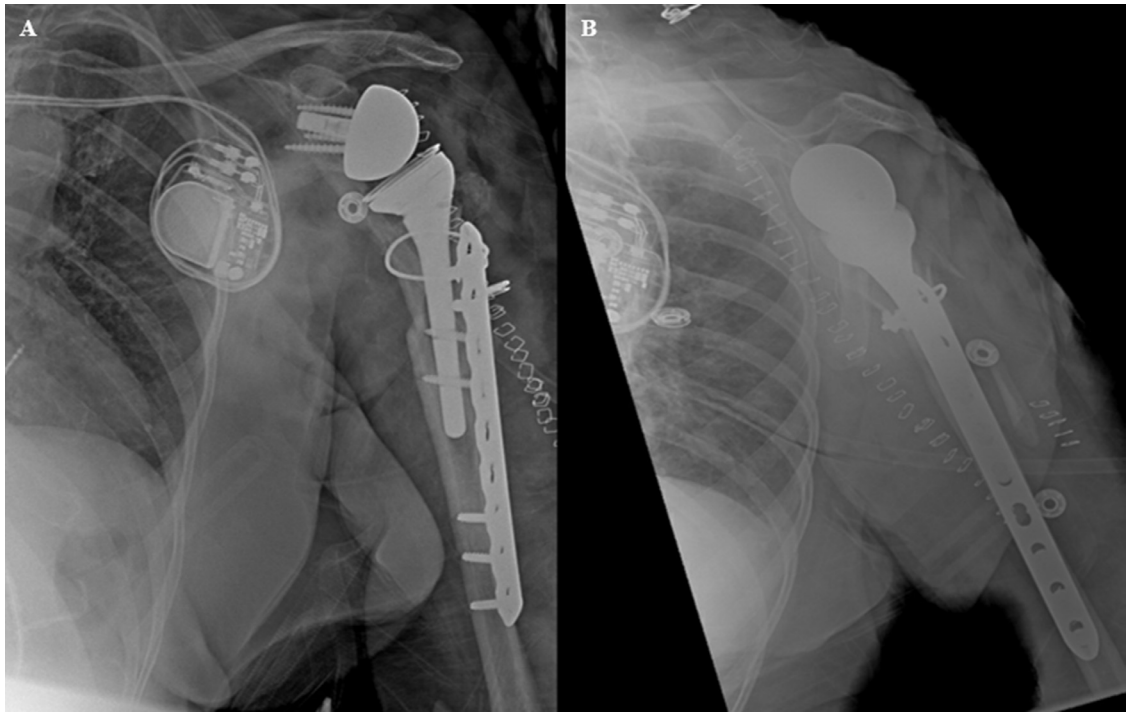

Figure 4 – Postoperative radiographs of an 85-year-old female who underwent reverse total shoulder prosthesis with plate osteosynethesis for failed intramedullary nail fixation. (A) Anteroposterior and (B) lateral views.

Both patients underwent a routine postoperative course with standard arthroplasty rehabilitation protocols without complication. They were immobilized for 3-4 weeks and then started gentle, unrestricted passive motion, advancing to active motion as tolerated. Strengthening was initiated at 4 months At 1-year follow-up, the first patient had fracture consolidation without implant failure (Fig. 6). Her abduction and external/internal rotation strength was rated 4/5. She had 90° of active forward flexion with 50° of external rotation with her arm at her side. With her arm abducted at 90°, she had 80 and 30° of external and internal rotation, respectively. At her last follow-up visit, her American Shoulder and Elbow Surgeons score was 55 (40 pain, 15 shoulder function), with a reported pain score as low as 0 at prior visits. Her Single Assessment Numerical Evaluation score was 80. For the second patient, at 20-month follow-up, radiographs also showed

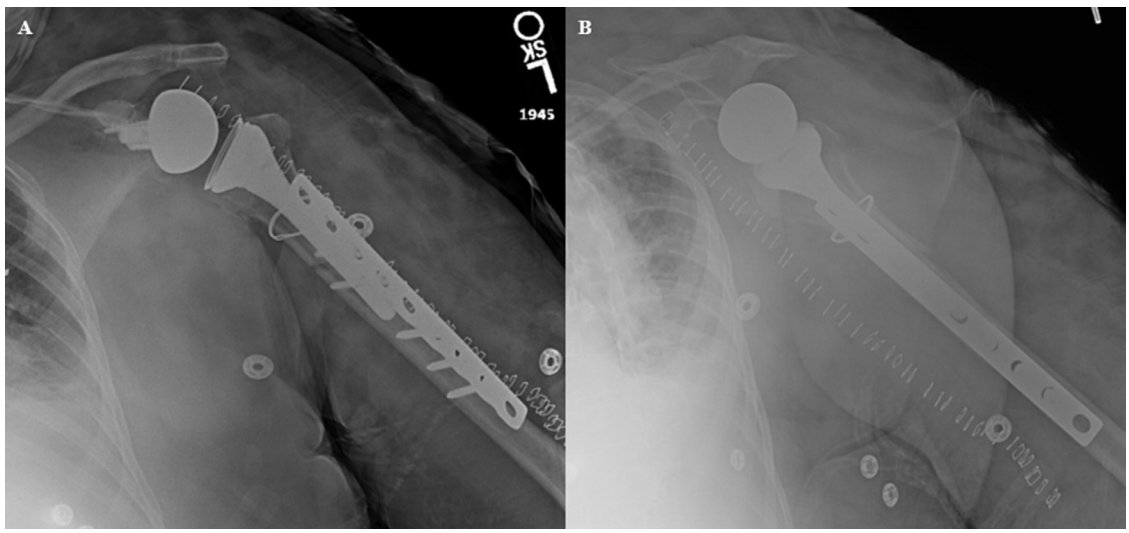

Figure 5 – Postoperative radiographs of a 72-year-old female who underwent reverse total shoulder prosthesis with plate osteosynethesis for a comminuted metadiaphyseal proximal humerus fracture. (A) Anteroposterior and (B) lateral views.

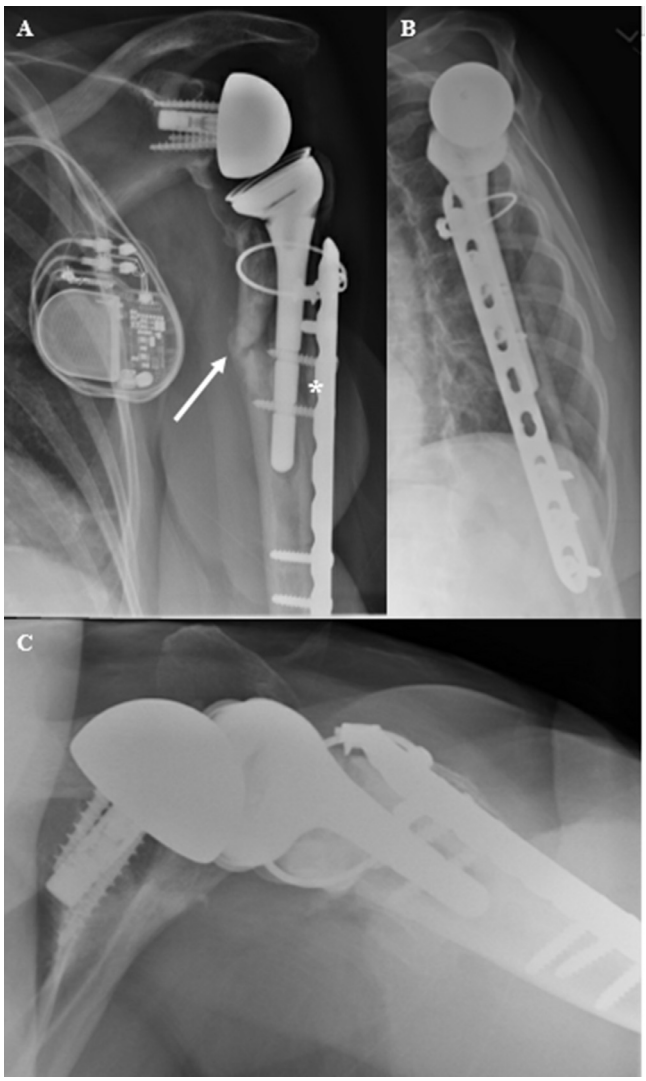

Figure 6 – One-year postoperative radiographs of an 85-year-old female who underwent reverse total shoulder prosthesis with plate osteosynthesis for failed intramedullary nail fixation. (A) Anteroposterior view showing medial cortical osseous bridging (arrow) across prior fracture site with minor resorption laterally (astericks), (B) lateral view, and (C) axillary view.

fracture consolidation without implant failure (Fig. 7). She had full strength, including all rotator cuff distributions, and 120° of active forward flexion with 30° of external rotation with her arm at her side. With her arm abducted at 90 degrees, she had 70 and 30° of external and internal rotation, respectively. Her American Shoulder and Elbow Surgeons score was 50 (15 pain, 35 shoulder function), with a pain score as low as 3 at prior visits that varied with rainy and cold weather patterns. Her Single Assessment Numerical Evaluation score was 72.

Discussion

Humeral shaft fractures with concomitant proximal comminution of the humeral head or glenoid with or without associated degenerative humeral head pathology can be challenging to treat. In this small, 2-patient case series, we present a novel technique utilizing an interlocking reverse shoulder arthroplasty stem combined with a 4.5 mm compression plate to address these challenging cases. At 1-year and 20-month follow-up periods, respectively, both patients had satisfactory results with no signs of implant failure.

Other constructs can be used to treat these injury patterns. While cemented stems have demonstrated good results when used for isolated proximal humerus fractures,[10,13] in the setting of fracture extension into the humeral shaft, it is possible that cement extrusion may interfere with bony union. Additionally, cement application can potentially interfere with tuberosity healing via thermal necrosis. Other techniques to avoid this complication use bone graft around the proximal cement mantle, the “Black and Tan” technique, and show tuberosity healing rates nearing 90%.[3] By using a plate to span the humeral shaft fracture and interlock into the stem, rotational stability is conferred without cementation. Alternatively, press fit long stemmed components have demonstrated good utility in the setting of poor proximal bone stock in both primary[8] and revision arthroplasty.[6] Despite obtaining secure fixation, complication rates can be frequent. In a case series of eighty revision arthroplasties,[6] the authors found high rates of cortical perforation (8%), cement extrusion (9%), and fracture nonunion (6%). Our construct avoids both cortical perforation and cement extrusion.

For periprosthetic fractures that overlap the tip of the stem or extend distally, either revising the humeral prosthesis to a long stem or open reduction internal fixation can be done. Due to the solid construct of standard stems, only unicortical screws or cerclage wires can be used proximally for fixation. While robust fixation can be achieved with cerclage wiring, it has been suggested that this technique can compromise periosteal blood flow and result in osteonecrosis or nonunion.[7] In the present case report, passing bicortical interlocking screws through the plate and stem has the advantage of creating a stronger construct compared to unicortical screws and without potentially sacrificing the periosteal blood supply with multiple cerclage cables. Further, cementless and locked stems for reverse arthroplasty have been used successfully in a 65-patient series treated for 3- and 4-part proximal humerus fractures.[2] In this study, at an average follow-up period of 15 months, functional outcomes were satisfactory with an average Constant score of 77.6. Other options including utilizing a fibular strut graft in conjunction with a cable plate system for periprosthetic fractures have also been reported.[12]

Maintaining correct humeral version for metadiaphyseal fractures can be challenging due to inadequate fixation proximally. This problem is addressed using distal interlocking screws to stabilize humeral version. Further, the added stability from plate fixation may afford better healing potential for the proximal fragment compared to isolated prosthesis placement. Healing of the calcar and proximal segment may avoid the instability associated with proximal humerus bone loss. Additional stabilization could include fixation of the calcar fragment aside from the cerclage wire. Although the design of the plate and stem would not allow for direct screw fixation of the calcar fragment, future designs could include more proximal interlocking options in the stem. Finally, as

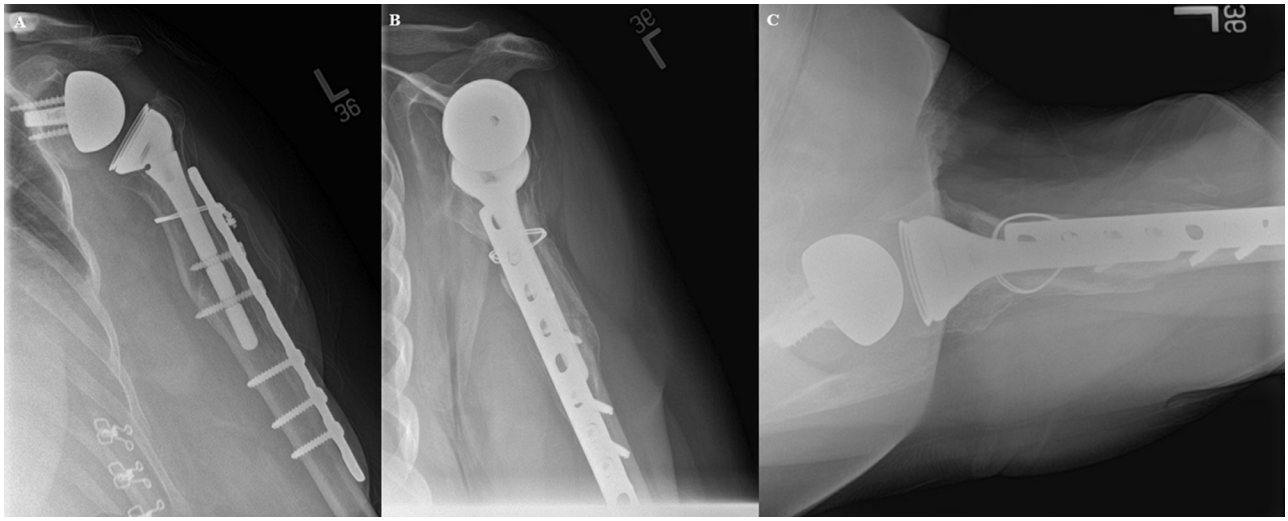

Figure 7 – (A-C) Twenty-month postoperative radiographs of a 72-year-old female who underwent reverse total shoulder prosthesis with plate osteosynethesis for a comminuted metadiaphyseal proximal humerus fracture. (A) Anteroposterior view showing fracture consolidation (B) lateral view, and (C) axillary view.

with standard stems and plates, unless a full-length humerus plate is used, which would require substantially more dissection, a stress riser is created at the distal margin of the plate. Periprosthetic fracture or implant complications associated with the locking stem itself are rare.[2]

Conclusion

Patients with degenerative or traumatic humeral head pathology with concomitant metadiaphyseal fractures can be challenging to treat. We present a small, 2-patient case series using RTSA with a stem interlocked to a compression plate. This novel technique offers a viable alternative to current methods to treat these injuries and avoids potential complications associated with cementation and long-stemmed implants. The added stability of this approach may be particularly beneficial in scenarios with proximal humerus bone defects.

Disclaimer

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