Concurrent Ipsilateral Total Elbow Arthroplasty and Reverse Total Shoulder Arthroplasty: A Case Report and Review of the Literature

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Introduction

Intra-articular fractures of the humerus at the shoulder or elbow are common yet difficult injuries to address in elderly patients with osteoporotic bone. In this patient population, poor bone quality often precludes rigid fracture fixation. As such, joint replacement options may provide more predictable functional outcomes for many of these injuries. Articular insufficiency fractures that occur concurrently in the same upper extremity present an additional challenge for the treating orthopaedic surgeon.

We report the use of an ipsilateral reverse total shoulder arthroplasty and total elbow arthroplasty in an elderly patient who suffered comminuted distal and proximal humerus fractures in the same arm.

Case Report

A 74 year-old, right hand-dominant female was referred to our facility one week after sustaining an injury to her left shoulder and elbow after a fall. The patient lived independently and had tripped on an uneven sidewalk resulting in a fall directly onto her left upper extremity. She presented with the chief complaint of left shoulder and elbow pain and limited range of motion. The patient denied any history of prior shoulder or elbow pain, instability, or dislocation. Her past medical history was otherwise unremarkable. On physical examination, the patient had significant ecchymosis and tenderness to palpation about the left proximal and distal humerus with limited range of motion and crepitus at the elbow and shoulder joints. She had no neurological deficits. Radiographs of the left shoulder and elbow revealed a head-splitting fracture of the proximal humerus and a comminuted intercondylar fracture of the distal humerus (Figures 1 and 2).

Due to the significant articular comminution at each fracture, poor bone quality, and the patient's age, the possibilities of both surgical fixation of the fractures and arthroplasty for both the shoulder and/or elbow were discussed. The patient expressed understanding that these factors rendered arthroplasty the most likely option pending intraoperative assessment.

Figure 1. Preoperative distal humerus AP radiograph.

Figure 2. Preoperative proximal humerus AP radiograph.

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pronator mass, which was partially torn from the fracture. The ulnar nerve was identified and decompressed at all points of compression from the arcade of Struthers down to Osborne's ligament in the cubital tunnel. The ulnar nerve was protected the rest of the procedure within the flexor pronator mass. The triceps insertion was left intact throughout the procedure to facilitate immediate active elbow motion postoperatively and to ensure soft tissue coverage of the implant.

The intercondylar fracture was assessed and was reconstructable. Attention was first turned to preparation of the ulna by cutting the tip of the olecranon. The humeral and ulnar preparations for a semi-constrained, Coonrad-Morrey (Zimmer) total elbow prosthesis were performed in standard fashion. As there was no capitellum from which to reference the humeral length, the provisional condylar reconstruction, anterior humerus, and epicondylar axis were used to reference humeral implant length, version, and rotation. Components were trialed to ensure full elbow extension and 145 degrees of flexion. Fluoroscopy was used to confirm implant position. A bone wedge was prepared to graft distally with the anterior humeral flange. Finally, the humeral and ulnar components were cemented into place with the arm held in full extension (Figure 3). Once the cement was cured, range of motion of the elbow was tested with full extension and 145 degrees of flexion achieved. Both full pronation and supination were preserved. The epicondyles were debulked, and the shell of epicondylar bone with attached soft tissue was repaired to the implant and humeral shaft using non-absorbable suture. An anterior subcutaneous transposition of the ulnar nerve was performed and the wound closed in a layered fashion over a drain. No tourniquet was used, blood loss was 100mL, and operative time was approximately 70 minutes.

Next, attention was turned to the fracture of the proximal humerus. A standard deltopectoral approach was utilized. After identification of the cephalic vein, the deltopectoral interval was dissected with lateral retraction of the vessel. Both the musculocutaneous and axillary nerves were identified and protected. The subdeltoid, subacromial, and subcoracoid spaces were developed.

The clavipectoral fascia was incised and the fracture hematoma was evacuated. Fracture fragments were identified and sutures were placed in the rotator cuff to control the proximal fragments. There was a humeral head split with the majority of the articular segments of the humeral head having no soft tissue attachment. Given the fracture pattern, risk of avascular necrosis, and patient's age, the decision was made to proceed with reverse total shoulder replacement. The humeral head fragments were removed and the tuberosities were debulked. The long head of the biceps was released from the supraglenoid tubercle and the glenoid was exposed. The glenohumeral capsule was released circumferentially. The glenoid was prepared by drilling a central pin in the inferior half of the glenoid with inferior inclination. The pin was then drilled over and baseplate reaming was performed by hand. Excellent press fit and bicortical screw fixation secured the glenoid baseplate. A 36mm standard glenosphere was seated over the Morse taper.

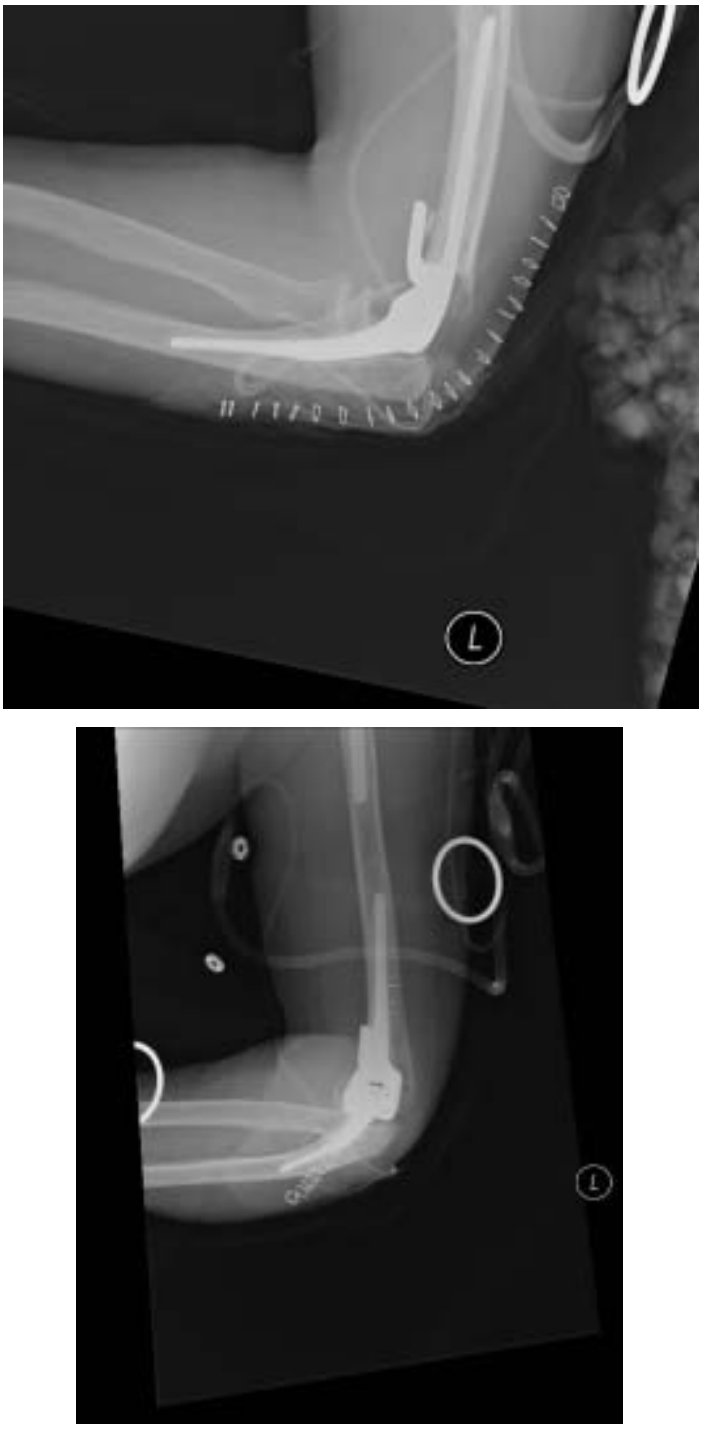

Figure 3. Postoperative elbow AP and lateral radiographs.

The humerus was prepared next with sequential reaming up to 10mm. The 10mm reamer was found to have good cortical chatter and a larger size or diaphyseal press fit implant was avoided to minimize creation of a stress riser between the total elbow humeral and total shoulder implants. Therefore, an 8mm trabecular metal stem was cemented in 10 degrees of retroversion. Next, a 36mm, plus-3, standard polyethylene liner was trialed and offered the best soft tissue tension while preserving motion. The plus-3 liner was then impacted in

place. At this point in time, the debulked greater and lesser tuberosities were repaired with non-absorbable sutures passed through the implant to restore the transverse force couple (Figure 4). No superior rotator cuff tissue was repaired. The wound was irrigated and a deep drain was placed. The incision was then closed in a standard layered fashion. A sterile stocking was applied to ensure uniform compression to minimize swelling and the patient was placed in a sling.

Postoperatively, small hemovac drains were placed in the elbow and shoulder. These were removed postoperative day one. A soft dressing and sling were applied. Occupational therapy was utilized for hand motion, edema control, and forearm rotation. Gravity pendulum hangs were initiated at two days postoperatively.The patient was instructed to remain non-weight bearing for three weeks, after which full-time use of the sling was stopped. Active elbow extension and flexion was allowed after the first week. Formal physical therapy for the shoulder and elbow were delayed until three week radiographs were reviewed by the attending surgeon.

Discussion

Ipsilateral arthroplasty of the shoulder and elbow was first established as treatment for patients suffering from upper extremity rheumatoid arthritis.[1-4] Typically, these procedures were performed in a staged fashion. Gill *et al* retrospectively studied eighteen two-stage ipsilateral total elbow and total shoulder arthroplasties in seventeen patients with rheumatoid arthritis and found fair to excellent clinical outcomes for both joints in seventeen cases (9 excellent, 4 good, 4 fair).[2] The time between surgeries ranged from three months to ten years with neither time between surgeries nor their sequence found to influence outcomes. Friedman and Ewald also found two-stage ipsilateral shoulder and elbow arthroplasties to have no compromise of patient motion, function, or pain.[5] Similarly, one-stage ipsilateral arthroplasty of the shoulder and elbow has also been established in the setting of rheumatoid arthritis with good outcomes. Vrettos *et al* studied twenty one-stage ipsilateral shoulder and elbow arthroplasties with all patients showing significant improvement in pain and function.[4] The authors favored one-stage surgery as a more cost-effective and safer means of addressing ipsilateral joint arthroplasty by allowing the patient to undergo one hospital admission, one exposure to anesthetic agents, and earlier rehabilitation.To our knowledge, only one previous case of a one-stage ipsilateral shoulder and elbow arthroplasty has been documented in the traumatic setting.[1] In that prior published case report, a total elbow arthroplasty was performed immediately followed by a shoulder hemiarthroplasty. In the patient with ipsilateral shoulder and elbow fractures, the benefits of earlier pain control and rehabilitation are potentially even greater as compared to the risk-benefit ratio of one- versus two-stage surgery in an elective setting.

Figure 4. Postoperative shoulder AP radiograph.

The proper sequence of single-stage ipsilateral upper extremity joint replacement remains controversial. Advocates of performing the shoulder arthroplasty first declare a decreased risk of rupturing recently repaired ligaments and subluxation of the elbow that can be stressed during the external rotation needed for exposure of the proximal humerus.[6] This risk is lower with the use of a linked elbow implant.[1,2] Moreover, in the traumatic setting of a fragmented proximal humerus, this risk is theoretically decreased by the fracture pattern offering improved exposure of the shoulder joint. Performing the elbow arthroplasty first creates a stable distal segment, which can provide easier manipulation of the upper extremity and allow more accurate placement of the shoulder arthroplasty by using the forearm and epicondyles as a guide for rotation of the proximal humerus.[1,3] As such, we chose to initially address the distal humerus.

Our decision to then proceed with a reverse total shoulder arthroplasty deviates from the previously published case report in which a hemiarthroplasty was used to address the proximal humerus fracture. Hemiarthroplasty remains the treatment of choice for proximal humerus fractures in which fragment fixation is contraindicated in patients under the age of 70.[7-9] However, hemiarthroplasty for proximal humerus fractures is not without its complications, and functional outcomes are less predictable than pain relief. The most common of these complications compromising function is nonunion or malunion of the repaired tuberosities.[10] If such a nonunion occurs, the resultant lack of rotator cuff attachment leaves

the patient without shoulder function above waist height. Tuberosity malunion or malpositioning also leads to altered glenohumeral contact forces and diminished function.[11,12]

Because of the less predictable functional results for hemiarthroplasty in elderly patients with unfixable proximal humerus fractures, reverse shoulder replacement has been advocated as a means of eliminating pain and avoiding reliance on accurate and secure tuberosity fixation. Reverse shoulder arthroplasty indications have expanded from the initial indication of rotator cuff tear arthropathy to include treatment complex proximal humerus fractures in elderly, low-demand patients.[13-15] The advantage of reverse shoulder arthroplasty is that it permits the patient to rely less on rotator cuff function and tuberosity healing.[13-15] In the case of our elderly female patient who suffered a severely comminuted fracture pattern of the proximal humerus, the concern for healing of her tuberosities and of the risk of subsequent humeral head avascular necrosisis eliminated.

Regardless of shoulder arthroplasty design choice, one of the concerns that remain when performing ipsilateral upper extremity joint replacements is the potential increased risk of fracture between the humeral components.[1,2,4,16] With the humeral component of the shoulder proximal and the humeral component of the elbow distal, the remaining portion of bone not violated by reaming, cement, or stem is a small fraction of the humeral length. This small segment of uninterrupted bone is theoretically subjected to increased torsion and bending stress that can lead to a stress riser between the two components.[1,2] In the setting of osteoporotic bone that is often encountered in the elderly population, this fracture risk is further increased.[2] Initially, many authors recommended various techniques such as maximizing component length or filling in a cement mantle to decrease the possibility of a periprosthetic fracture.[2,17] However, a biomechanical study by Plausinis *et al* found no significant reduction in bone stress when longer stemmed prostheses or cement between the two components was used.[16] The authors felt the use of cement in the unviolated canal posed potential difficulties with component revision and prosthetic revision. Similarly, the use of longer stemmed prostheses would leave the patient with less potential bone stock in the event of a revision. The authors concluded that cemented shoulder and elbow components could be considered independent of one another in terms of risk of periprosthetic fracture. In our patient, the shoulder humeral component was sized to obtain a metaphyseal press fit only, leaving the diaphyseal cortices undisturbed. Similarly, smaller diameter total elbow components were cemented into place, again in an effort to minimize the risk of future diaphyseal fracture.

Conclusion

Patients with ipsilateral proximal and distal humerus fractures pose a serious challenge for the treating orthopaedic surgeon. For patients unwilling or unable to undergo extensive rehabilitation following fracture fixation, concurrent total elbow and shoulder arthroplasty may allow for early functional restoration while minimizing the complications associated with multiple procedures or hospital admissions. We report on one such case of ipsilateral proximal and distal humerus fractures in which a one-stage reverse shoulder arthroplasty and total elbow arthroplasty resulted in minimal hospitalization, early rehabilitation, and excellent patient satisfaction.

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