Keywords: Orthopedics, Fracture, Nonunion, Smoking, Shoulder pain

BACKGROUND
Fractures involving the proximal humerus rank among the most common injuries encountered by orthopaedic surgeons worldwide.1 Most are due to low-energy forces that result in non-displaced or minimally displaced fractures that are managed without surgery.2 An uncommon but challenging complication of either surgical or non-surgical management is nonunion. Fracture nonunions often present with significant shoulder dysfunction and pain that can disrupt the ability to perform activities of daily living.3 There are many factors that may contribute to an increased risk of nonunion including fracture pattern and comorbidities such as osteoporosis, alcoholism, tobacco use, diabetes, and obesity.4 In particular, smoking may be one of the most significant risk factors as smokers are at 5.5 times higher risk than non-smokers for developing nonunion.5 These issues must be recognized and optimized in order to support adequate fracture healing and prevent complication.

There are many approaches to managing proximal humeral nonunion. Nonsurgical management is reserved for cases involving poor surgical risk due to medical comorbidities, high risk for noncompliance with postoperative rehabilitation and precautions, or minimal pain and minor functional losses. The goal of surgical management is to create a stable construct that permits early motion and an environment that encourages fracture healing. Surgical strategies to achieve these goals include osteosynthesis with locking plate fixation, fixed-angle locked plating with fibular strut allograft, intramedullary nailing, and unconstrained and reverse total shoulder arthroplasty.6 Management decisions must be catered to the clinical presentation and each patient’s preferences and goals regarding therapy.

Because of the frequency of humeral fractures and the significant disability of nonunion, all medical professionals must be able to recognize and manage increasing cases of nonunion. Here we present a case involving nonunion of a proximal humerus fracture after open reduction internal fixation with a locking plate that was successfully repaired using a reverse total shoulder arthroplasty prosthesis.

CASE PRESENTATION
A 51 year-old right-hand-dominant, Caucasian female presented to the Texas Tech University orthopedic clinic with a history of chronic left shoulder pain following open reduction and internal fixation (ORIF), at an outside facility, for a fracture involving the left proximal humerus that occurred as the result of a fall from standing height 13 months prior to presentation. At presentation, she reported constant pain both at rest and activity, weakness, and decreased range of motion involving the left upper extremity while her review of systems was negative.

Past medical history is significant for gastroesophageal reflux disease, osteoporosis, 35 pack year smoking history, and an otherwise negative past surgical history. Her BMI is 21. She works full time as a hospital monitor technician; however the symptoms have disrupted her ability to perform all of her duties and forced her to stop working temporarily.

Examination of the left upper extremity revealed a well-healed left shoulder deltopectoral incision, and her arm was neurovascually intact. Range of motion was limited to about 20° in forward flexion, abduction, and external rotation. Any motion caused significant pain, and her rotator cuff muscles, particularly the supraspinatus, were weak.

Radiographs revealed a proximal humerus fracture with a lateral locking plate. The fracture did not achieve union. The humeral head had rotated and was not congruent with the glenoid (Figure 1).

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Figure 1: AP X-Ray. Proximal humerus fracture treated with locking plate which developed into non-union and displacement of humeral head.

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Treatment modalities included both surgical and non-surgical. Non-surgical options would include injections and physical therapy. However, because of her poor function, pain, and fracture non-union the patient opted to proceed with surgical correction of the non-union. Surgical options included revision ORIF and shoulder arthroplasty. Reverse total shoulder arthroplasty is an excellent option for many patients including those with painful arthritis and rotator cuff tears in elderly patients. This approach was felt to be the most favorable treatment option based on our patient’s poor quality of bone, lack of rotator cuff repair, and her medical comorbidities that originally led to failure to achieve union.

The incision was made over the previous scar via a deltopectoral approach. The locking plate and screws, and the nonunion site were excised. A reverse total shoulder arthroplasty was inserted (Figure 2). Intra-operatively it was noted that significant scarring was present throughout the shoulder, advanced arthritis, and poor quality rotator cuff tendon.

Nonunion occurs through the disruption of the blood supply and vasculature that are necessary for proper healing of the fracture. Our patient had two significant risk factors which lead to poor healing of the initial ORIF: long standing tobacco use and osteoporosis. In older patients with osteoporosis, there is a high risk of repair failure with classic plate-and-screw fixation due to the bony architecture of the humeral head and poor quality of central cancellous bone. Cigarette smoking is highly detrimental to bone health, causing decreased bone mineral density, delayed bone healing, and increased risk of perioperative complications by a variety of mechanisms.

The standard of care in treatment of proximal humeral nonunions is considered to be the formation of a stable construct through the use of locking plates and autogenous bone graft; however in other cases, shoulder arthroplasty may be necessary as a salvage option. Indications for reverse total shoulder arthroplasty include nonunion with humeral head collapse, dysfunctional rotator cuff, radiologic rotator cuff atrophy, or severe tuberosity malunion or resorption. Reverse total shoulder arthroplasty has been demonstrated to be successful in the repair of failed hemiarthroplasty for proximal humeral fracture, tumor resection, rotator cuff tear arthropathy, and fracture sequelae. Cheung and Sperling further postulate that it would be a viable option in elderly patients with proximal humeral nonunion to alleviate pain and improve shoulder function. Moreover, Martinez et al reported significant improvements in range of motion with high satisfaction rates in a study of 18 patients treated with reverse total shoulder arthroplasty for proximal humeral nonunion.

Optimal treatment of patients with either proximal humerus fractures or the subsequent complication of nonunions require care provided by a team of medical professionals not limited to the orthopedic surgeon.

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CONCLUSION
Nonunion is a recognizable complication that follows a classic presentation consisting of shoulder pain, stiffness, and disability associated with dysfunction at approximately 6 to 9 months following repair of a fracture involving the proximal humerus. History will often include several risk factors and comorbidities that precipitated the development of nonunion. Proper management of these factors by a coordinated medical team can dramatically reduce the occurrence and improve treatment outcomes. Reverse total shoulder arthroplasty represents a viable option for repair of proximal humeral nonunion in patients with poor bone quality, rotator cuff pathology, and other comorbidities. Though there have only been a few cases reported, favorable outcomes have been demonstrated. Knowledge of nonunion as a complication of proximal humeral fractures and its presentation, diagnosis, and treatment options will aid physicians in avoiding unnecessary complications and reducing disability.

REFERENCES