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Humeral shaft fracture after open biceps tenodesis following use of continuous passive motion machine: a case report



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Introduction

Pathology of the biceps, which can include tenosynovitis, biceps tendon subluxation or dislocation, and tears, is a common pain generator of the shoulder. Surgical treatment options include biceps tenotomy and biceps tenodesis. Biceps tenotomy is a safe procedure but can result in cosmetic deformity and muscle cramping in certain patient populations.^{4,11} Subpectoral tenodesis involves fixation of the long head of biceps in the distal aspect of the bicipital groove and decreases the morbidity associated with tenotomy. Various techniques have been described to achieve biceps tenodesis including use of an interference screw, suture anchor or, cortical button. The overall complication rate of biceps tenodesis is low; however, adverse events can be severe and include fractures of the humerus.^{1,9,10} Cortical defects such as drill holes have been shown to biomechanically reduce the bone's resistance to stress, creating stress risers that increase the risk of fracture.⁴

In this report, we present a patient with a proximal humeral shaft fracture 4 weeks after a subpectoral biceps tenodesis. The fracture propagated through the tunnel used for the biceps tendon. The fracture occurred postoperatively while using a continuous passive motion (CPM) machine for abduction and external rotation motion. This is the first report to associate a humeral shaft fracture after open biceps tenodesis with use of a CPM machine. This complication and review of the literature suggest there may be

merit to limiting patients' external rotation for a period of time postoperatively following a subpectoral biceps tenodesis.

Case report

The patient was a 47-year-old right-hand-dominant man who presented with right shoulder pain after a remote injury 8 years earlier. He had undergone multiple rounds of nonoperative treatment including injections and physical therapy. On physical examination, he demonstrated active range of motion to 85° abduction, 90° forward elevation, and 45° external rotation. Passive motion was 100° abduction, 110° forward elevation, 50° external rotation with pain. He had positive Jobe's, cross-body adduction, O'Brien's, Hawkins impingement test, and tenderness over the acromioclavicular joint. Magnetic resonance imaging findings demonstrated a posterior labral tear, biceps tendinopathy, and acromioclavicular joint arthropathy.

He was treated with a right shoulder arthroscopy, open subpectoral biceps tenodesis, labral and rotator cuff débridement, and distal clavicle excision; there were no intraoperative findings suggestive of adhesive capsulitis. A subpectoral biceps tenodesis was performed. The tendon was fixed using a bicortical endobutton technique with a 6-mm unicortical tunnel placed within the bicipital groove. An adequate "plunge" was appreciated after drilling the proximal cortex indicating near concentric tunnel placement. There was no redirection of the guidewire. The biceps tendon was tightened within the tunnel, and a knot pusher was used to tie the knot along the distal cortex.

Two weeks after surgery, he began using a CPM machine protocol for all patients having undergone shoulder arthroscopic procedures without rotator cuff repairs. The initial CPM protocol involved forward flexion only. Four weeks after surgery, the

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protocol was advanced to include abduction and external rotation. While performing his second round of this exercise, he felt a sharp pain and pop in his arm. He was evaluated in a local emergency room and was diagnosed with a transverse humeral shaft fracture. The fracture propagated through the 6-mm tunnel hole and above the drill hole for the endobutton. The button was still supported by the distal cortex (Figure 1, A and B). He was fitted for a functional brace. Radiographs at 2 weeks after injury demonstrated that the fracture remained at an acceptable length, rotation, and alignment. Five months after fracture, radiographs demonstrated acceptable alignment and union of his injury (Figure 2, A and B). He had full, painless range of motion of the shoulder and no pain at the fracture site. He was cleared to begin advancement of resisted exercise. At approximately 1 year from injury, he reported no pain or limits in his right shoulder function. His American Shoulder and Elbow Surgeons shoulder score and Disabilities of the Arm, Shoulder, and Hand Score were calculated as 0 and 100, respectively.

Discussion

Biceps tenodesis remains an effective procedure with a complication rate of approximately 2% which is largely attributed to complaints of persistent pain or loss of fixation.⁸ Several case reports of humeral shaft fracture after subpectoral biceps tenodesis have been reported.^{3,10} Overmann et al evaluated the incidence and characteristics of humeral shaft fracture after subpectoral biceps tenodesis.⁹ They reviewed more than 15,000 biceps tenodesis procedures and found 11 postoperative and 1 intraoperative humeral shaft fracture. The overall incidence was found to be 7.9 of 10,000 cases. Fractures were found with all methods of fixation to include suture anchor, interference screw, and cortical button. Importantly, two fractures were atraumatic.

Cortical defects such as bone tunnels create stress risers and can increase the risk of fracture.^{2,7} Euler et al³ performed a biomechanical analysis of the effect of screw malpositioning on proximal humeral strength during subpectoral biceps tenodesis. They found

that the eccentrically malpositioned tenodesis sites decreased humeral strength by 25% ($P = .017$) compared with concentrically placed screws by 10% ($P = .059$).

At surgery, open subpectoral tenodesis drill sites are significantly more distal than those performed only arthroscopically.^{4,5,7} Johannes De Villiers⁶ assessed torque stress in a biomechanical model and compared proximal vs. distal position of tenodesis. Sites located both 1-cm proximal and distal to the pectoralis major insertion were assessed. Maximum torque at the distal sites was decreased compared with more proximal sites. Although this was not statistically significant, it may indicate an increased risk of postoperative humerus fractures with more distal tenodesis sites. Beason et al¹ specifically evaluated torsional external rotation failure of the humerus after subpectoral biceps tenodesis with an interference screw via a biomechanical cadaveric study. They found no statistical difference between screw sizes; however, when combining data for both screws, biceps tenodesis resulted in a 35% reduction in maximum torque and a 48% reduction in rotation to failure. A study by Edgerton et al² demonstrated that a 20% cortical defect resulted in a 34% decrease in torsional strength of a cadaveric humerus.

During surgery, it is difficult to establish whether or not the tunnel is eccentrically placed. Therefore, it is difficult to assess which patients are at increased risk for humeral fracture postoperatively. Because the humerus is least resistant to torsional forces, it may be wise to avoid external rotation after biceps tenodesis. CPM machines should be used with caution after biceps tenodesis. When external rotation is initiated postoperatively, it should be performed in a supervised and progressive manner.

Conclusion

Biceps tenodesis is an excellent treatment for biceps pathology with good results and low incidence of complications. The humerus is susceptible to fracture with torsional strains and a stress riser further decreases the load to failure. CPM machines should be used

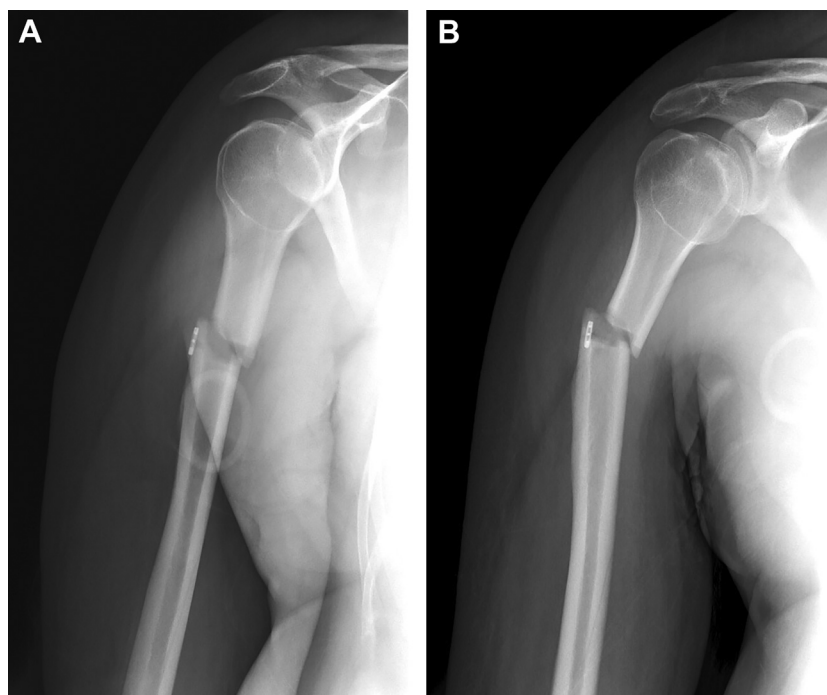


Figure 1 (A and B) AP and lateral plain radiographs of the right humerus demonstrating a transverse humerus shaft fracture at the level of the biceps tenodesis cortical button.

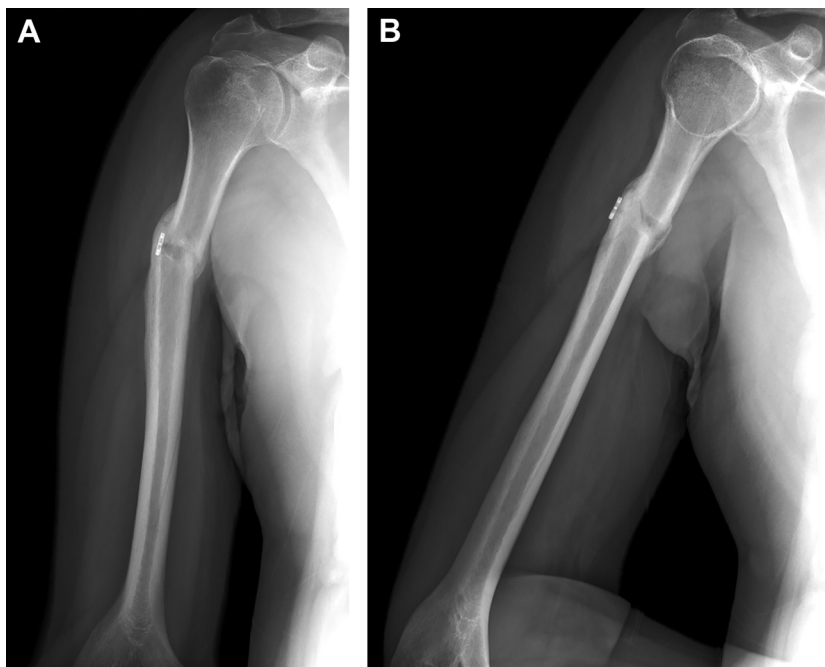


Figure 2 (A and B) AP and lateral plain radiographs of the right humerus demonstrate an acceptably aligned and healed humerus shaft fracture with significant callus formed at four cortices.

with caution after subpectoral biceps tenodesis. It may be advisable to limit activities; however, considerations may differ based on specific patient variables such as age, activity level, and gender.

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