ELSEVIER

Operative Techniques in

Sports Medicine

# Arthroscopic and Open Treatment of Olecranon Apophyseal Injuries in the Athlete

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**Elbow injuries are quite common in the athletic population with overhead throwing athletes at more risk than nonthrowing athletes. These injuries frequently manifest as acute traumatic events or sequela of chronic repetitive stresses on the stabilizing anatomical structures of the elbow. Overuse stress-related olecranon osseous injuries occur in both skeletally mature and immature athletes, and both nonoperative and operative treatment options have provided good outcomes. However, early identification of the injury and appropriate consideration of factors such as age, contralateral physeal closure, fracture displacement, sclerosis, and response to conservative care afford the best opportunity of success with the least risk for surgery, complication, or lost performance. The authors present an alternative classification scheme and treatment algorithm for olecranon injury, including arthroscopic and open surgical techniques for adolescent and young athletes with olecranon stress fractures and both mature and immature radiographic skeletal findings.**
**Oper Tech Sports Med 25:259-268** 

**KEYWORDS** olecranon, stress fracture, apophysis, athlete

## Introduction

Elbow injuries are quite common in the athletic population with overhead throwing athletes at more risk than nonthrowing athletes.[1] These injuries frequently manifest as acute traumatic events or sequela of chronic repetitive stresses on the stabilizing anatomical structures of the elbow.

Elbow ossification occurs at 6 different centers in a set order and fusing at different ages. As the multiple centers coalesce, they produce 1 of 2 common types of the final olecranon apophysis. The 2 common types include an extra-articular line extending proximally into the triceps origin or as a serpentine line extending across the mid-olecranon process into the sigmoid fossa. During overhead throwing, a large valgus load is conferred on the elbow resulting in a tensile load on the medial elbow, shear forces posteriorly, and compressile forces laterally. Repetitive valgus loads conferred by humeral torque can lead to attenuation of the ulnar collateral ligament (UCL) resulting in instability. If the UCL becomes incompetent, the posteromedial structures of the elbow become relied upon for stability during throwing. These shear stresses in the posterior compartment can lead to pathology including cartilage injury, osteophytes, enthesophytes, loose bodies, and stress fracture.

A classification scheme of olecranon injuries in athletes was originally described by Nakaji et al[2] and then expanded to 5 categories by Furushima et al.[3] The authors present an alternative classification scheme and treatment algorithm, including arthroscopic and open surgical techniques for adolescent and young athletes with olecranon stress fractures and both mature and immature radiographic skeletal findings.

## Goals

The goals of treatment for olecranon stress injuries are resolution of stress reaction or fracture healing, resolution of pain and joint dysfunction, motion and strength recovery, and finally return to unlimited sport participation at the same or higher level of performance. As these injuries are seen in a

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*Disclosure*: Senior author (J.E.C.) is on Editorial Board for AJSM and receives royalties from Arthrex.

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http://dx.doi.org/10.1053/j.otsm.2017.08.004
1060-1872//

variety of sports, the biomechanics of injury will vary accordingly and so will be the treatment algorithms. Baseball pitchers and high-level gymnasts represent the 2 groups of athletes where these stress-related olecranon injuries occur most often. In the thrower, where correctable, proximal kinetic chain dysfunction often contributes to the concentration of pathologic forces on the elbow, a comprehensive assessment of the whole athlete is essential to a successful outcome with both conservative and postoperative rehabilitation programs addressing such issues as kyphothoracolumbar posture, landing leg quadriceps weakness, hip motion loss, lumbopelvic-hip malalignment, core strength deficiencies, scapular malposition and dyskinesia, shoulder motion loss (based on humeral torsion measurements), shoulder stabilization (addressing entities such as Dynamic Posterior Instability in a Thrower), and correction of known throwing mechanic factors that contribute to injury.

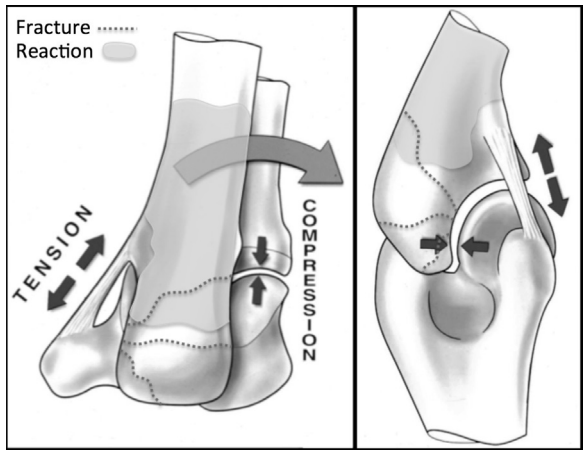


**Figure 1** Diagram demonstrating biomechanical forces acting on the thrower's elbow, and the location of the 4 common mature skeleton olecranon stress fracture patterns.

## Biomechanics of Olecranon Injury

There are 4 different areas of stress that the elbow experiences in the throwing motion including anterior, lateral, medial, and posterior. Each area has different pathology associated with chronic repetitive loads including osteochondritis dessicans, medial epicondyle apophysitis and fractures, UCL injury, and olecranon stress injuries and avulsion fractures. With the throwing motion, chronic repetitive stresses can overload the medial elbow restraints leading to compression overload on the lateral articular surfaces, posteromedial overload on the posterior articular surfaces and extension overload on the lateral restraints (Fig. 1).[4] Stresses across the posterior compartment lead to valgus extension overload, and in the adolescent, this can lead to separation of the olecranon ossification center. If left untreated, this can lead to an unfused olecranon apophysis and when symptomatic nonunion exists, surgical management is indicated. In skeletally mature athletes, these posterior stresses can lead to osteophytic change with exostoses as well as stress fracture. Enthesopathy with avulsion fracture is another mechanism of olecranon apophyseal injury to be considered in the differential of injury.[5]

## Initial Evaluation

The initial evaluation should include a thorough history and physical examination highlighting the mechanism of injury, localization of pain, and duration of symptoms. Apophyseal injuries usually present with an insidious onset and can be associated with a change in activity or mechanics. The pain is typically progressive over the course of weeks and is rarely reported with the onset of a "pop." Additionally, the pain is associated with activity, and the athlete usually does not have pain at rest. On physical examination, a thorough evaluation including range of motion, point tenderness, strength, stability testing, and neurovascular status should be performed. Point tenderness with bone pain can be confirmed with percussion as well as vibration. Radiographs are obtained to evaluate for periosteal new bone, enthesopathy, endosteal thickening, cortical radiolucency, linear sclerosis, and late fracture lines. When radiographs appear normal and there is a high degree of suspicion, a 3-phase bone scan can be helpful with early diagnosis.[6,7] All 3 phases of bone scan are positive when stress fracture is present. Magnetic resonance imaging can be used in evaluation for other concomitant soft tissue injury, but with stress fracture, it may be positive late or provide a false negative. It can be useful in detecting bony edema based on sequencing and can be used to monitor nonoperative treatment with resolution of edema.[8,9]

## Classification of and Proposed Treatment Algorithm for Olecranon Injuries

(1) Immature skeleton
  (a) Proximal extra-articular apophyseal stress fracture.
  (b) Distal intra-articular apophyseal stress fracture.
(2) Mature skeleton
  (a) Diffuse proximal ulna and olecranon stress reaction.
  (b) Oblique-mid olecranon stress fracture.
  (c) Transverse-proximal olecranon stress fracture.
  (d) Olecranon tip stress fracture.

The senior author has previously described 6 common olecranon stress fracture patterns[10] in adolescent and young athletes, 2 in the immature skeleton[11] and 4 in the mature skeleton. In the immature skeleton, the olecranon physeal line forms in 1 of 2 planes: either as an extra-articular linear line extending proximally into the triceps origin or as a serpentine line extending across the mid-olecranon process into the sigmoid fossa.