Other Entities: PLRI, HO, Triceps, and Plica

26

Wade C. VanSice, Michael J. O'Brien, and Felix H. Savoie III

Posterolateral Rotatory Instability

Introduction

Posterolateral rotatory instability (PLRI) of the elbow is a well-defined instability pattern, originally described by O'Driscoll in 1991 [1]. PLRI results from an incompetent radial ulnohumeral ligament (RUHL), also known as the lateral ulnar collateral ligament (LUCL). When the RUHL is nonfunctional, the radial head subluxates posterolaterally off of the capitellum during forearm supination, and the ulnohumeral joint begins to gap. As the pattern of instability continues the entire, elbow joint may dislocate [1].

PLRI is identified through a combination of history and physical examination. The most common etiology is trauma, such as falling onto an outstretched hand or a simple elbow dislocation, but it may also result from iatrogenic injury. PLRI resulting from cortisone injections or surgery for lateral epicondylitis has been described [2, 3].

Patients with PLRI will complain of lateral-sided elbow pain and discomfort with activities. They will frequently report mechanical symptoms of locking, catching, and clicking or a palpable "clunk" with certain activities [1]. This is typically noted at mid-flexion as the elbow goes into extension, especially with the forearm supinated. Lateral-sided elbow instability can be very debilitating. Activities of daily living, such as opening doors or lifting objects in front of them with the elbow extended, become painful and difficult [4, 5]. Pushing up from a chair or a seated position can cause pain and feelings of instability, as the combination of supination, valgus force, and axial load causes the radial head to subluxate posterolaterally.

The diagnosis of PLRI is best demonstrated clinically with the *lateral pivot shift test* of the elbow. This test, first described by O'Driscoll [1], can be performed in the supine or prone position and will elicit gross instability or simply pain and apprehension. Two additional clinical tests have been described by Regan and colleagues [6] and are also useful in the diagnosis of PLRI. The *chair push-up test* is performed with the patient pushing up from an arm chair with the palms facing inward and forearms supinated. The *table-top relocation test* requires the patient to push up from a prone or wall-leaning position first with the forearms maximally pronated and then repeat the test with the forearms maximally supinated. The tests are considered positive when they reproduce the patient's pain, instability, or both [6].

The diagnosis is confirmed with magnetic resonance imaging (MRI) arthrography. In the acute setting, injection of contrast is not necessary as blood in the joint from the traumatic injury serves as contrast medium. The RUHL is usually avulsed from its origin on the posterior aspect of the lateral epicondyle of the humerus. In the chronic setting, laxity of the lateral collateral ligament complex will be evident, with posterolateral subluxation of the radial head from the capitellum.

Once diagnosed, surgery is necessary to correct persistent instability. In most instances, the ligament has failed to heal with conservative treatment. Instability can be confirmed arthroscopically through several findings, including subluxation of the radial head on the capitellum and the arthroscopic "drive through sign" of the elbow, where the arthroscope in the posterior portal can be driven from the lateral gutter across the ulnohumeral articulation into the medial gutter. This maneuver is not possible in the stable elbow. Acute repairs, both open and arthroscopic, heal with excellent

W.C. VanSice, MD, MPH (✉) • F.H. Savoie III, MD
Department of Orthopedic Surgery, Tulane University School of Medicine, Tulane Medical Center, New Orleans, LA, USA
e-mail: wvansice@tulane.edu; fsavoie@tulane.edu

M.J. O'Brien, MD
Department of Orthopedic Surgery, Division of Sports Medicine, Tulane University School of Medicine, Tulane Medical Center, New Orleans, LA, USA
e-mail: mobrien@tulane.edu

S.F. Brockmeier (ed.), *MRI-Arthroscopy Correlations: A Case-Based Atlas of the Knee, Shoulder, Elbow and Hip*,
DOI 10.1007/978-1-4939-2645-9_26, © Springer Science+Business Media New York 2015

patient outcomes [2]. In the chronic setting, graft reconstruction may be required.

This report describes cases of arthroscopic repair of the RUHL in the acute and chronic setting. A high index of suspicion is necessary to correctly diagnose this condition in patients with lateral elbow pain and feelings of instability.

Case 1: Acute Elbow Dislocation

History/Exam

A 17-year-old high school football running back presented to the orthopedic clinic 1 day following a traumatic elbow dislocation to his nondominant arm. He fell onto his outstretched left hand while being tackled and sustained a closed posterolateral elbow dislocation, which was reduced on the field of play. He had no history of previous injury to the elbow. At presentation, his left elbow was immobilized in a posterior long arm splint. He complained of diffuse pain and swelling in the elbow on both the medial and lateral sides.

Physical examination revealed swelling on both sides of the elbow with skin intact. Range of motion was stable from 30 to 120° of flexion with full rotation and feelings of instability at terminal extension. He had tenderness over both medial and lateral collateral ligaments, instability to valgus stress, and evidence of posterolateral rotatory instability with lateral pivot shift testing. Neurologic testing was intact distally in the extremity.

Imaging

Radiographs were obtained with four views of the elbow including anteroposterior (AP), lateral, and oblique projections. Radiographs revealed a concentric reduction of the ulnohumeral joint with no fractures or subluxations. In some cases, radiographs may reveal an avulsion fragment from the posterior aspect of the lateral epicondyle of the humerus. An MRI without contrast was obtained the following day. Injection of contrast was not necessary in the acute period. A complete sequence of images was obtained, including axial T1 and fat-saturated T2 sequences, oblique coronal fat-saturated T1 and T2 sequences, and oblique sagittal T1 and fat-saturated T2 sequences. Coronal T2-weighted images are demonstrated in Fig. 26.1a, b, sagittal T2-weighted images in Fig. 26.2a, b, and axial T2-weighted image in Fig. 26.3.

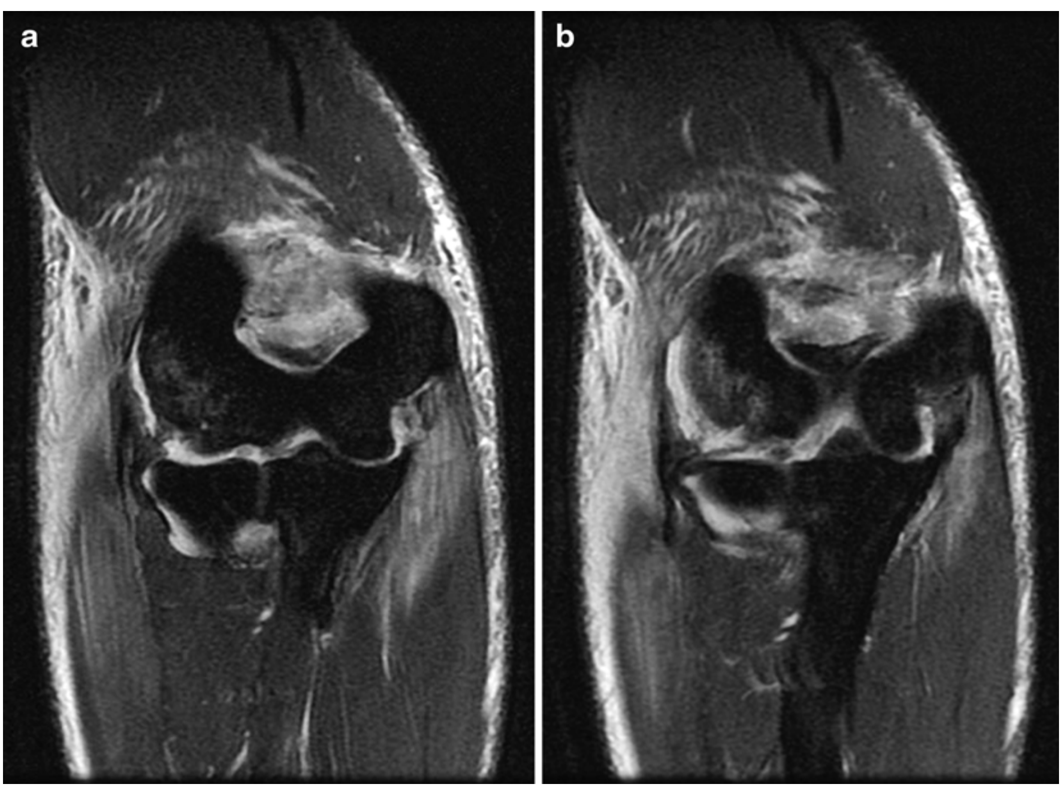

Fig. 26.1 (**a**, **b**) T2-weighted coronal oblique MRI images demonstrate tearing of the RUHL and LCL complex off the posterior aspect of the lateral epicondyle of the humerus, laxity in the annular ligament around the radial head, and edema in the bone of the lateral epicondyle and surrounding musculature. **a** also shows tearing in the mid-substance of the MUCL with avulsion distally off the sublime tubercle of the ulna (**a**, **b**: Published with kind permission. Copyright © Felix H. Savoie, III, MD)

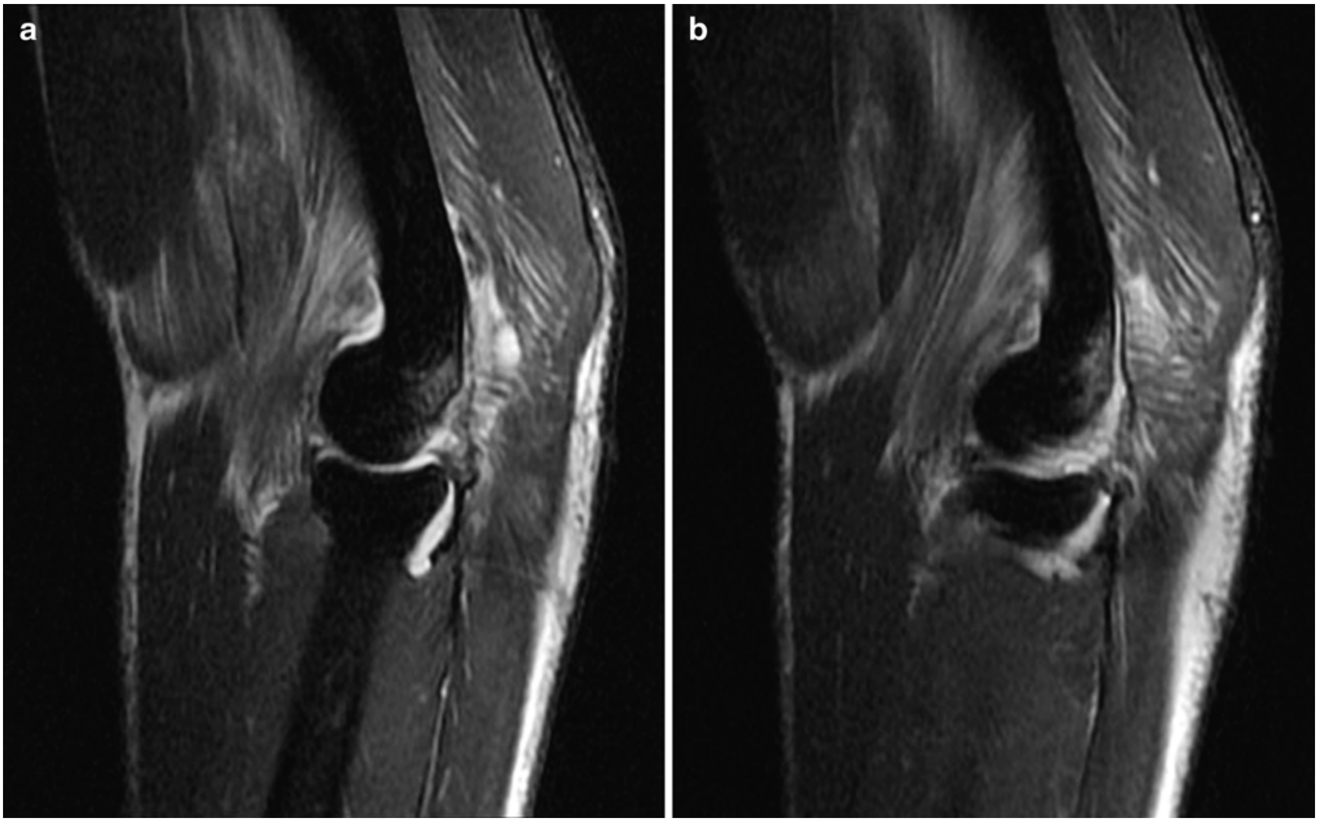

Fig. 26.2 (**a**, **b**) T2-weighted sagittal oblique MRI images demonstrate tearing of the RUHL and LCL complex off the posterior aspect of the lateral epicondyle of the humerus, laxity in the annular ligament, edema in the bone posteriorly, and edema in the brachialis muscle anteriorly and triceps muscle posteriorly (**a**, **b**: Published with kind permission. Copyright © Felix H. Savoie, III, MD)

MRI revealed concentric reduction of the ulnohumeral joint with no interposed soft tissues. On the lateral side, the RUHL complex is avulsed from the posterior aspect of the lateral epicondyle of the humerus (Fig. 26.1a, b) with edema seen in the bone at the avulsion site. On the medial side, midsubstance tearing of the medial ulnar collateral ligament (MUCL) and avulsion from the sublime tubercle on the ulna are demonstrated in Fig. 26.1a. Surrounding edema with increased signal intensity is visualized in the common flexor/pronator muscle origin in Fig. 26.1a. Sagittal oblique T2 sequences (Fig. 26.2a, b) also demonstrate avulsion of the RUHL complex from the posterior aspect of the lateral epicondyle, with edema in the brachialis anteriorly and triceps muscle posteriorly. Axial T2 image (Fig. 26.3) demonstrates avulsion of the RUHL in the upper right corner of the image. The left side of Fig. 26.3 shows tearing of the anterior capsule, edema in the brachialis muscle, and hematoma in the anterior compartment of the elbow joint.

Given the identified RUHL avulsion on MRI consistent with the patient's history and clinical examination of elbow dislocation, risks and benefits of operative intervention were discussed with the patient. He was the starting senior running back for his high school football team and had verbally committed to a college program. His team was the #1 seed, favored to play in the state championship game, and had already earned a first-round bye in the play-offs. He had one regular season game remaining, with 2 weeks before the team's first play-off game. Surgery was offered as a possible treatment for arthroscopic repair of the RUHL to stabilize the elbow and potentially return him to play faster in a brace. After an extensive discussion with the family of both operative and nonoperative treatment options, he elected to proceed with the proposed surgical intervention.

Arthroscopy

The patient was taken to the operating room and placed in the prone position with the operative arm placed on a bump over an arm board. A pneumatic tourniquet was used for the case. A standard diagnostic arthroscopy of the left elbow was completed. A standard proximal anteromedial viewing portal was established for the arthroscope and a working anterolateral portal established for the shaver. Hematoma in the anterior compartment was evacuated with the shaver, and tearing of the anterior capsule was evident with exposed muscle

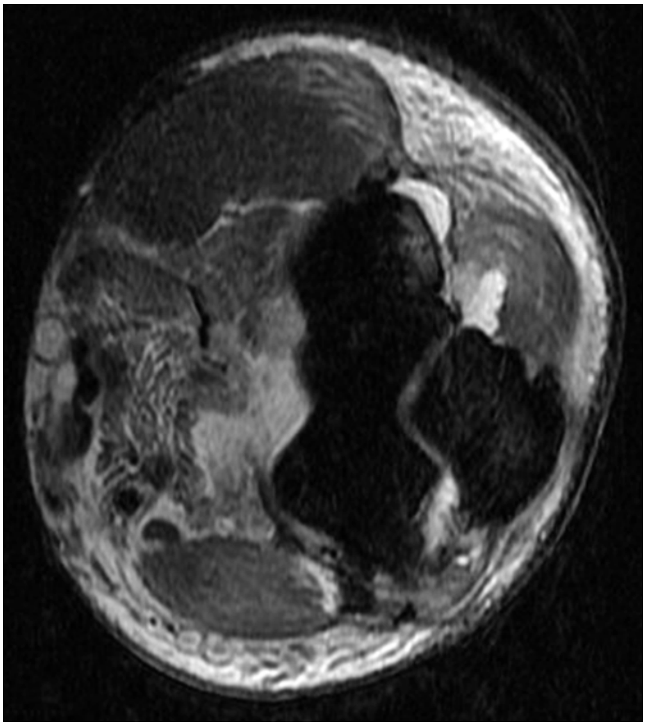

Fig. 26.3 A T2-weighted axial MRI image shows tearing of the RUHL off the posterior aspect of the lateral epicondyle in the *upper right corner* of the image. The *left side* of the image demonstrates tearing in the anterior capsule, edema in the brachialis, and hematoma in the anterior compartment of the elbow (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

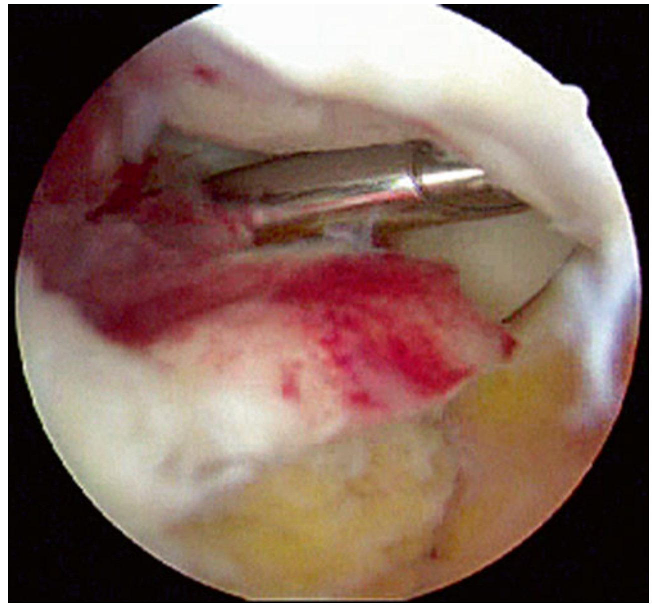

Fig. 26.4 An arthroscopic view of the posterolateral gutter in a left elbow, with the arthroscope in a posterior trans-tendon portal. The shaver is entering the posterior radiocapitellar joint through a lateral soft spot portal. The radial head is visible beyond the shaver. The stump of the RUHL is viewed in the center of the image, avulsed off the posterior aspect of the lateral epicondyle (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

fibers of the brachialis. Inspection of the radiocapitellar joint showed laxity in the annular ligament. Rotation of the forearm demonstrated posterolateral subluxation of the radial off the capitellum, indicative of posterolateral rotatory instability.

The arthroscope was then placed into the posterior compartment through a posterior trans-tendon portal. Hematoma in the olecranon fossa was evacuated with a shaver in a posterolateral portal. The site of avulsion of the RUHL off the posterior aspect of the lateral epicondyle was visualized just lateral and distal to the olecranon fossa. The arthroscope was easily advanced down the posterolateral gutter due to laxity in the lateral collateral ligament (LCL) complex. The avulsed RUHL was visualized distally in the posterolateral gutter near the level of the radiocapitellar joint (Fig. 26.4). The arthroscope could be advanced from the lateral gutter across the ulnohumeral joint and into the medial gutter, with a positive arthroscopic "drive through sign" of the elbow (Fig. 26.5).

The site of origin of the RUHL was roughened with a shaver, and a double-loaded 2.9 mm suture anchor was inserted percutaneously into the humerus at the origin of the ligament (Fig. 26.6). The sutures were placed down the lateral gutter with a suture retriever. Utilizing a lateral soft spot

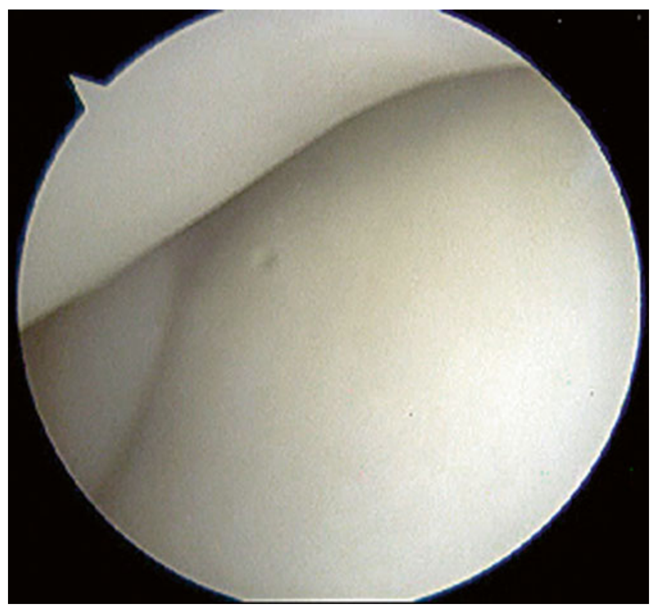

Fig. 26.5 The "drive through sign" of the elbow is demonstrated in this arthroscopic view of the ulnohumeral joint of a left elbow. The arthroscope is in the ulnohumeral joint, viewing from a posterior trans-tendon portal. The articular cartilage of the distal humerus is at the *top* of the image, with the articular cartilage of the ulna and proximal radioulnar joint at the *bottom* of the image (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

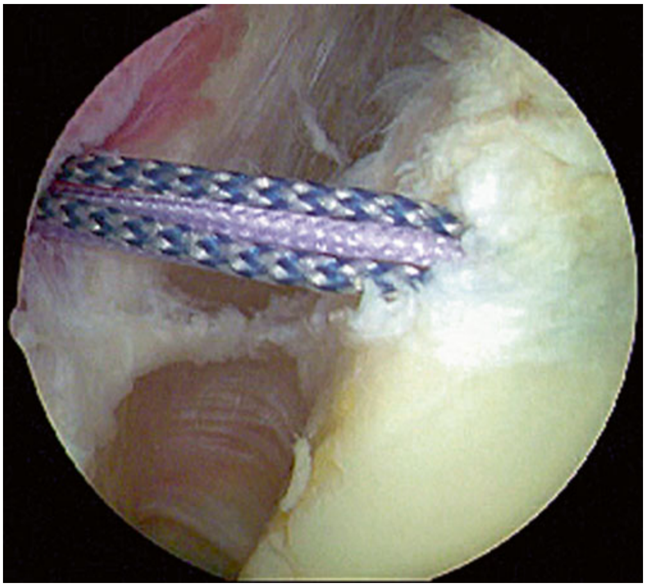

Fig. 26.6 An arthroscopic view of the posterolateral gutter in a left elbow with the arthroscope in a posterior trans-tendon portal. A double-loaded suture anchor has been inserted at the anatomic humeral origin of the RUHL just lateral and distal to the olecranon fossa on the posterior aspect of the lateral epicondyle (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

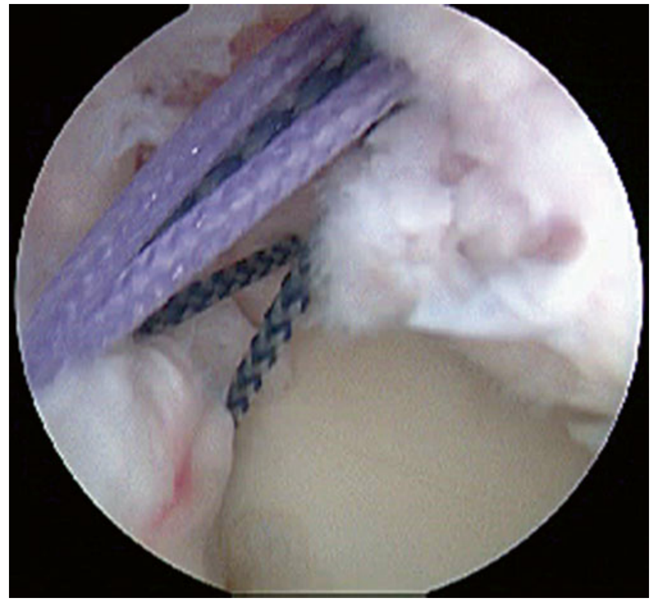

Fig. 26.7 An arthroscopic view of the posterolateral gutter in a left elbow with the arthroscope in a posterior trans-tendon portal. Mattress sutures have been placed through the healthy portion of the RUHL. The sutures have not yet been tied (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

portal and a percutaneous antegrade suture passer, two mattress sutures were placed in the healthy portion of the ligament. A second suture anchor was placed more distally with a mattress suture placed at the distal aspect of the ligament (Fig. 26.7). The sutures were retrieved and tied, placing the knots deep to the anconeus muscle. As the sutures were tied, tension was restored to the lateral collateral ligament complex, which had the effect of pushing the arthroscope out of the posterolateral gutter. The arthroscopic "drive through sign" could no longer be performed, indicating that adequate tension was restored to the lateral side of the elbow. The arthroscope was then placed back into the anterior compartment. Tension was restored to the annular ligament around the radial head, and the radial head no longer subluxated off the capitellum with forearm supination.

The patient was splinted for a week and then started physical therapy in a protective brace. The patient returned to play in the brace at 3 weeks, participation in the semifinals and finals. The brace was eliminated at 4 weeks and progress in rehabilitation continued. The patient is currently in his third year of collegiate competition, with no subsequent elbow problems.

Case 2: Chronic PLRI

History/Exam

A 30-year-old, right-hand-dominant, male carpenter presented to the orthopedic clinic complaining of left elbow pain. He had fallen off a roof 3 months prior, landing on his outstretched left arm, and sustained a closed left elbow dislocation. The elbow was reduced in the emergency department, and he was treated conservatively in a hinged elbow brace for 6 weeks. He complained of lateral-sided left elbow pain, feelings of instability, and a palpable clunk with certain activities, especially lifting objects with the left elbow extended.

Physical examination of the left elbow revealed prominence of the radial head and intact skin with no swelling. Range of motion was 10 to 135° of flexion with full rotation. He had tenderness over the radial head and lateral epicondyle, especially posteriorly. He had no gross instability to varus or valgus stress, a positive lateral pivot shift test, and a positive chair push-up test. His wrist exam was normal, and he was neurologically intact distally.

Imaging

Radiographs were obtained with four views of the elbow including AP, lateral, and oblique projections. Radiographs revealed an oval, opaque density on the lateral side of the elbow at the level of the radiocapitellar joint (Fig. 26.8), a concentric reduction of the ulnohumeral joint, and no fractures or subluxations. An MRI arthrogram was ordered with a complete sequence of images; the MRI was ordered with intra-articular contrast, as this was a chronic case. Coronal T2-weighted images are demonstrated in Fig. 26.9a–c, coronal T1-weighted image in Fig. 26.10, sagittal T2-weighted image in Fig. 26.11, and axial T2-weighted image in Fig. 26.12.

MRI revealed concentric reduction of the ulnohumeral joint. On the lateral side, there were indistinctness and heterogeneity of the RUHL complex as it neared the humeral attachment

Fig. 26.8 An anteroposterior (AP) radiograph of a left elbow. A small oval density at the level of the radiocapitellar joint represents the avulsed RUHL off the humerus. The ulnohumeral joint is concentrically reduced, and there is slight lateral subluxation of the radial head off the capitellum (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

(Fig. 26.9a–c) and lateral subluxation of the radial head. Figure 26.9a shows the stump of the RUHL and a void near the humeral attachment. Figure 26.9b shows heterogeneity and thickening of the RUHL and LCL complex, with an intact MUCL on the medial side. Figures 26.9c and 26.10 show the stump of the RUHL in the radiocapitellar joint, with a small avulsed piece of bone on the most proximal aspect of the ligament. The sagittal oblique image (Fig. 26.11) demonstrates the torn RUHL at the level of the radiocapitellar joint. The radial head is subluxated posterior, and the bare area on the posterior aspect of the lateral epicondyle represents the humeral origin of the RUHL. Figure 26.12 also shows avulsion of the RUHL off the posterior aspect of the lateral epicondyle in the axial plane. There is no soft tissue or bony edema on any image sequence, confirming that this represents a remote injury.

The MRI findings of an avulsed RUHL were consistent with the clinical exam of PLRI. Due to the appearance of the RUHL on MRI sequences with a grossly intact ligament avulsed off the humerus with an attached small piece of bone, an arthroscopic repair was offered, with the possible need for open reconstruction. The risks and benefits of the surgery were discussed with the patient. He had failed nonoperative management with clinical instability of the elbow. After an extensive discussion with the patient, he elected to proceed with the proposed surgical intervention.

Arthroscopy

The patient was taken to the operating room and placed in the prone position. Examination under anesthesia demonstrated a positive lateral pivot shift test (Fig. 26.13a, b). A standard diagnostic arthroscopy of the left elbow was completed. As in the first case, laxity of the annular ligament was identified (Fig. 26.14). There was no hematoma in the anterior compartment as this was a case of chronic instability. Rotation of the forearm demonstrated posterolateral subluxation of the radial off the capitellum, indicative of posterolateral rotatory instability.

The arthroscope was placed into the posterior compartment through a posterior trans-tendon portal. The arthroscope was again easily advanced down the posterolateral gutter, due to laxity in the LCL complex. The RUHL with attached bone fragment was visualized distally at the level of the radiocapitellar joint. The synovium had a yellowish appearance due to the chronic nature of the injury (Fig. 26.15).

The site of origin of the RUHL was roughened with a shaver, and a double-loaded 2.9 mm suture anchor was inserted percutaneously into the humerus at the origin of the ligament. Using a percutaneous antegrade suture passer (Fig. 26.16), two mattress sutures were placed into the healthy portion of the ligament, incorporating the lateral capsule (Fig. 26.17). The sutures were retrieved and tied in the same manner as the first case, and tension was restored to the lateral collateral ligament complex.

Heterotopic Ossification

Introduction

Heterotopic ossification (HO) is the formation of bone in nonskeletal tissue, usually in muscle or outside the joint capsule. It most commonly affects the elbow and the hip [7] and presents following trauma, significant brain injury, or major burns with symptoms of stiffness or complete ankylosis [8]. Although the exact etiology is unknown, predisposing factors have been proposed that include increased prostaglandin activity, tissue hypoxia, alterations in the sympathetic nervous system, and immobilization [9].

Diagnosis is made with history and physical exam, specifically severe pain, stiffness, joint swelling, warmth, and lack of motion, and confirmed with radiographs. Lack of understanding limits the ability to treat heterotopic bone formation both before and after it has occurred [10]. Range of motion exercises and stretching [11–13], medical interventions such as indomethacin and disphosphonates [14, 15], and radiation

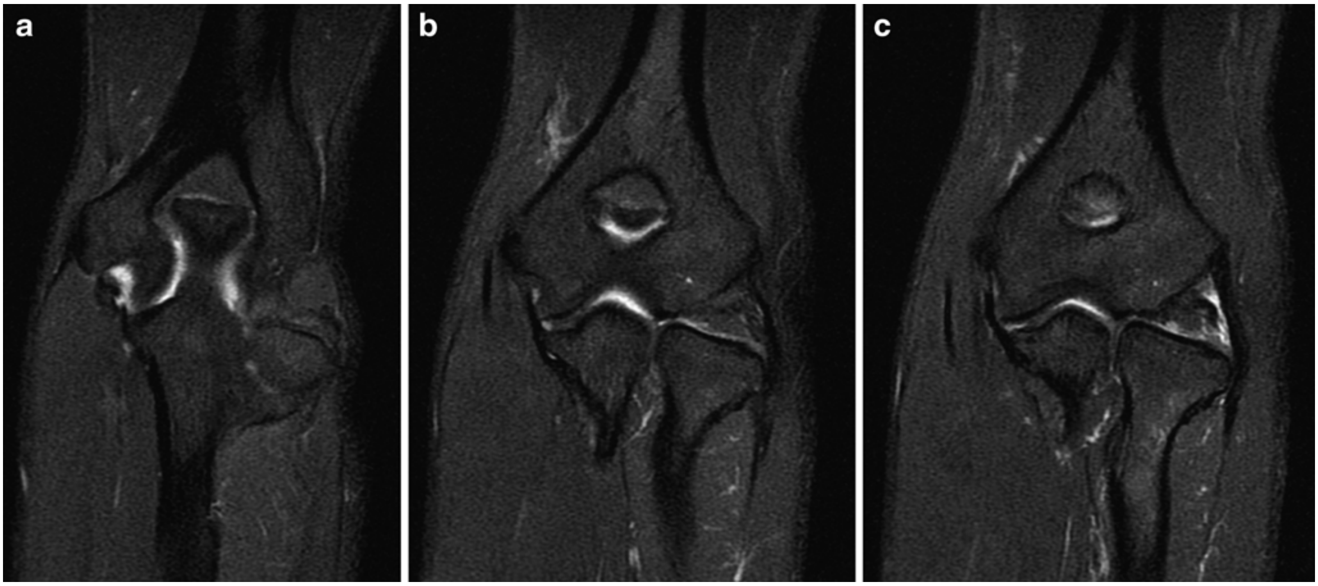

Fig. 26.9 (**a**–**c**) T2-weighted coronal oblique MRI images demonstrate tearing of the RUHL and LCL complex off the posterior aspect of the lateral epicondyle of the humerus. **a** shows the stump of the RUHL on the *right* of the image with a void of tissue at the humeral origin of the ligament. **b** shows heterogeneity in the LCL complex with an intact MUCL on the *left side* of the image. **c** shows the stump of the RUHL in the radiocapitellar joint and lateral subluxation of the radial head. The lack of edema in the bone and soft tissues confirms that this is a chronic injury (**a**–**c**: Published with kind permission. Copyright © Felix H. Savoie, III, MD)

Fig. 26.10 A T1-weighted coronal oblique MRI image demonstrates heterogeneity of the RUHL and LCL complex on the *right side* of the image with a small oval of avulsed bone in the stump of the RUHL (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

Fig. 26.11 A T2-weighted sagittal oblique MRI image shows tearing of the RUHL off the posterior aspect of the lateral epicondyle of the humerus, with posterior subluxation of the radial head off the capitellum (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

therapy [16] have all been proposed as potential treatment options for the prevention of HO.

When HO about the elbow does occur, open surgical procedures incorporating ectopic bone removal and contracture release are practical options for regaining elbow motion. Traditionally, open excision is recommended at approximately 6–12 months after diagnosis to ensure that the rapid growth phase is complete and the bone has matured [17]. However, arthroscopic excision is possible and has recently shown to be effective early in the process.

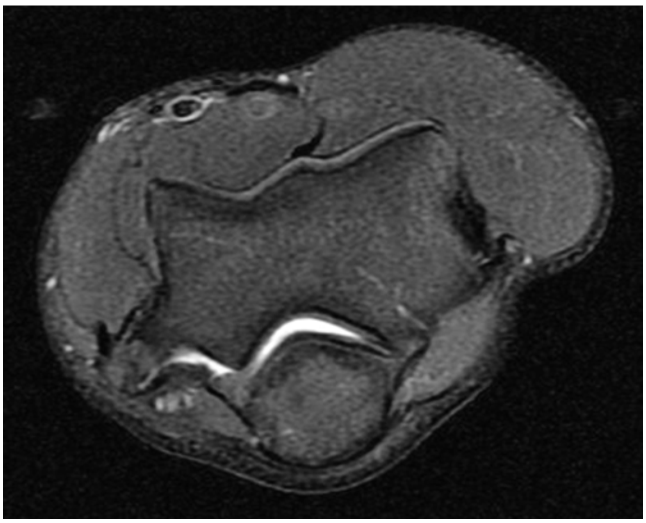

Fig. 26.12 A T2-weighted axial MRI image shows tearing of the RUHL off the posterior aspect of the lateral epicondyle of the humerus. There is no edema in the soft tissues and no hematoma in the anterior compartment of the elbow joint (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

Case 1: Heterotopic Ossification

History/Exam

A 52-year-old, right-hand-dominant female presented to the orthopedic clinic with a chief complaint of left elbow pain. She sustained an elbow dislocation and previously underwent arthroscopic elbow surgery with medial and lateral ligament repairs. Approximately 2 months following surgery, she began to develop worsening pain and stiffness in the left elbow, with loss of motion despite appropriate physical therapy. Examination of the elbow revealed healed incisions with no signs of infection, fullness posteriorly in the olecranon fossa with tenderness to palpation, and a flexion contracture with approximately 30–40° loss of full extension.

Imaging

Radiographs (Fig. 26.18a, b) obtained showed heterotopic ossification in the posterior compartment. An MRI without contrast was obtained with a complete sequence of images. Sagittal T1, T2, and T2-fat-saturated images (Fig. 26.19a–c) and an axial image (Fig. 26.20) demonstrate heterotopic bone in the posterior compartment deep to the triceps filling the olecranon fossa. Increased signal intensity in the bone and surrounding musculature shows that this is an active process with acute inflammation. The lack of cortical edges surrounding the developing bone demonstrates that the bone is still immature and soft.

Arthroscopy

She failed to progress in physical therapy, including aggressive stretching and dynamic bracing at home, and continued to have pain and a progressive loss of motion.

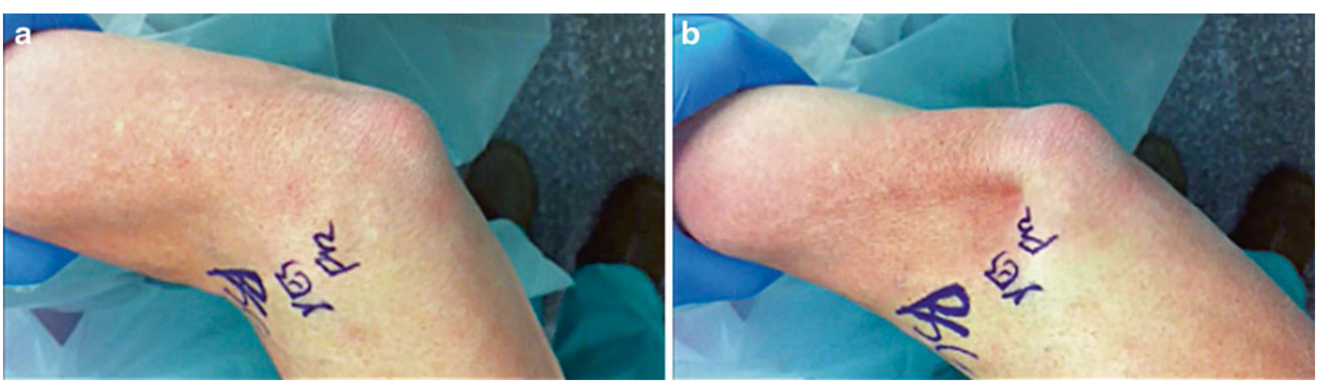

Fig. 26.13 (**a**, **b**) Photographs of the lateral pivot shift test in a left elbow. In **a**, the elbow is reduced. With axial load, valgus force, and supination, the radial head subluxates posterolaterally, and the ulnohumeral joint begins to dislocate (**b**). The dimple appears proximal to the radial head as the radial head dislocates (**a**, **b**: Published with kind permission. Copyright © Felix H. Savoie, III, MD)

Fig. 26.14 An arthroscopic view of the anterior compartment of a left elbow, viewed from a proximal anteromedial viewing portal. Inspection of the radiocapitellar joint shows laxity in the annular ligament and chronic synovitis in the anterior compartment (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

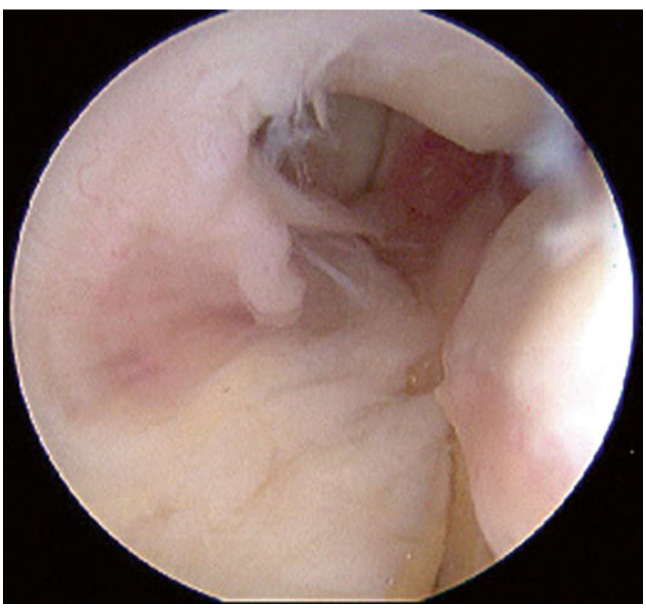

Fig. 26.15 An arthroscopic view of the posterolateral gutter in a left elbow with the arthroscope in a posterior trans-tendon portal. The avulsed RUHL is on the *left* of the image, sitting in the radiocapitellar joint. The posterior radiocapitellar joint is at the *top* of the image. The *yellowish* appearance of the ligament confirms the chronic nature of the injury (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

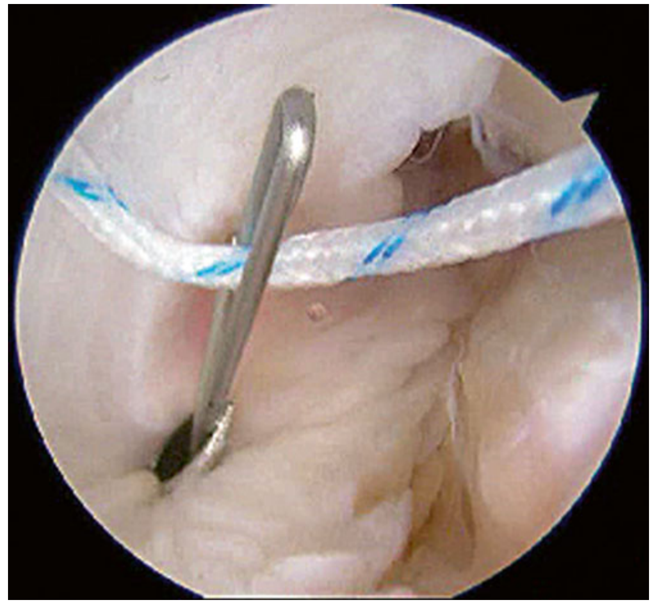

Fig. 26.16 An arthroscopic view of the posterolateral gutter in a left elbow. A suture has been placed down the lateral gutter. A percutaneous suture passer enters through a lateral soft spot portal to retrieve the suture through a healthy portion of the ligament (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

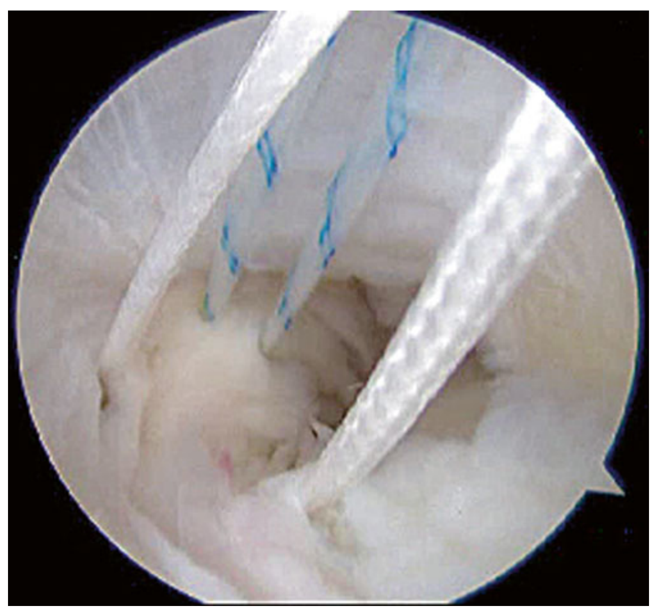

Fig. 26.17 An arthroscopic view of the posterolateral gutter in a left elbow. Two mattress sutures have been placed in the healthy portion of the RUHL (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

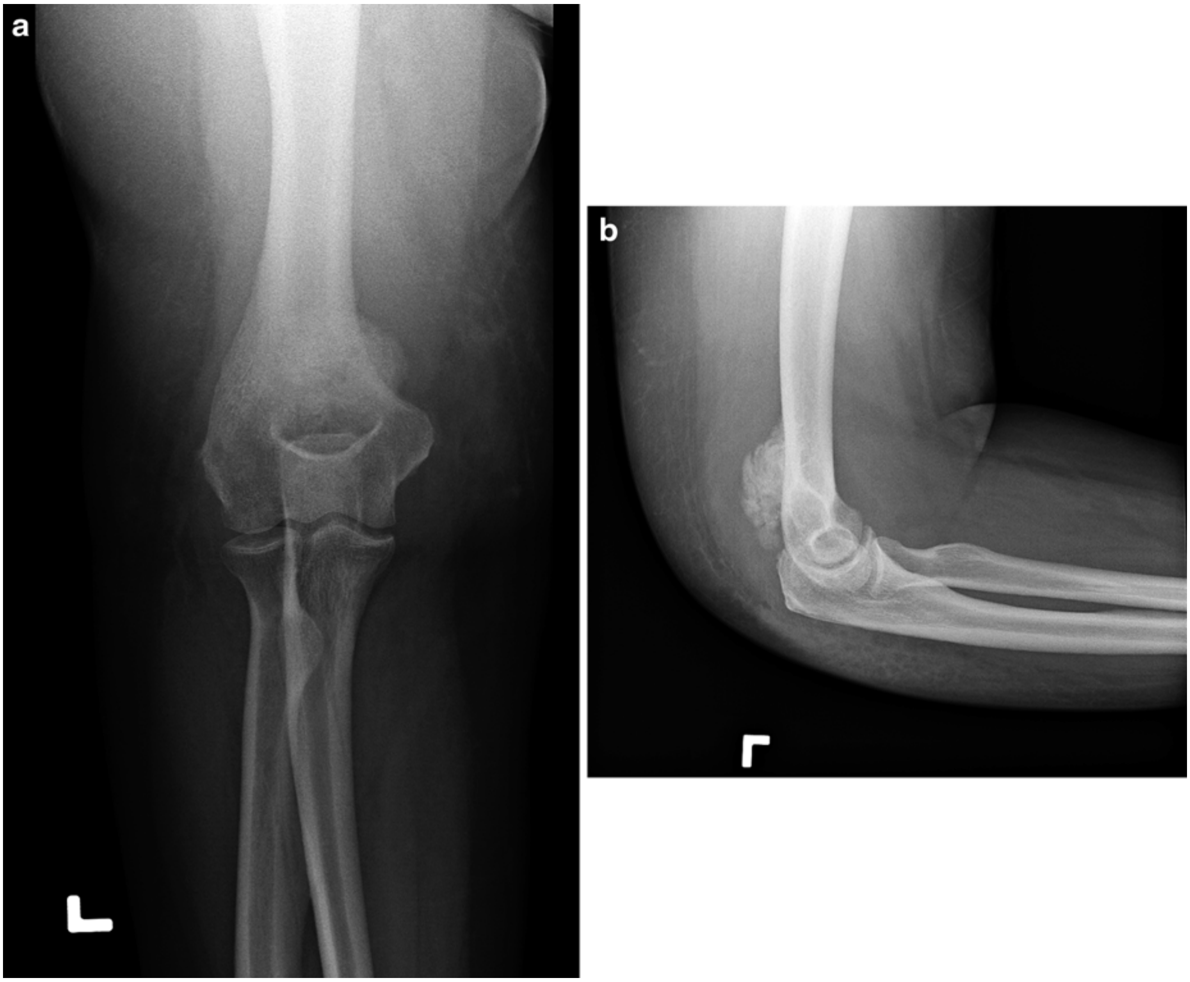

Fig. 26.18 (**a**, **b**) AP and lateral radiographs of the left elbow demonstrating the development of heterotopic ossification in the posterior aspect of the elbow. The lack of cortical edges to the bone shows that this is an immature bone (**a**, **b**: Published with kind permission. Copyright © Felix H. Savoie, III, MD)

Therefore, surgery was offered for arthroscopic debridement and resection of the HO. She was informed of risks and benefits of surgery, particularly neurovascular injury and recurrence of the HO, and informed consent was obtained.

Arthroscopic elbow surgery was performed in the prone position with the use of a pneumatic tourniquet and the operative arm positioned on an arm board with a bolster. Standard diagnostic arthroscopy was performed. Inspection of the anterior compartment revealed scar tissue with thickening of the anterior capsule, and an anterior capsulectomy was performed.

The arthroscope was then placed in the posterior compartment through a posterior trans-tendon portal. Using the blunt trocar, the arthroscope was driven through the distal extent of the heterotopic bone and into the olecranon fossa; the hard cortical bone at the base of the fossa stops advancement of the trocar. Next, a motorized shaver was placed into the center of the olecranon fossa through a posterolateral portal, and the heterotopic bone was excised. The immature spongy bone is very soft at this stage; it easily fragments and can be removed with the shaver (Fig. 26.21). The bone was excised until the tip of the olecranon could be viewed, and excision was continued proximally under the triceps tendon. A plane can be developed between the heterotopic bone and overlying triceps muscle. The resection was continued both medially and laterally, taking great care to protect the ulnar nerve on the medial side. The entire area of HO was excised (Fig. 26.22), using fluoroscopic images to confirm a full resection had been performed.

The patient was admitted overnight for pain control. A continuous passive motion (CPM) was initiated immediately postoperative. She received a single dose of radiation therapy to the elbow on postoperative day 1, prior to discharge, for the prevention of HO recurrence. She began aggressive physical therapy on postoperative day 2. Radiographs obtained 2 months postoperative (Fig. 26.23a, b) show that the HO did not recur.

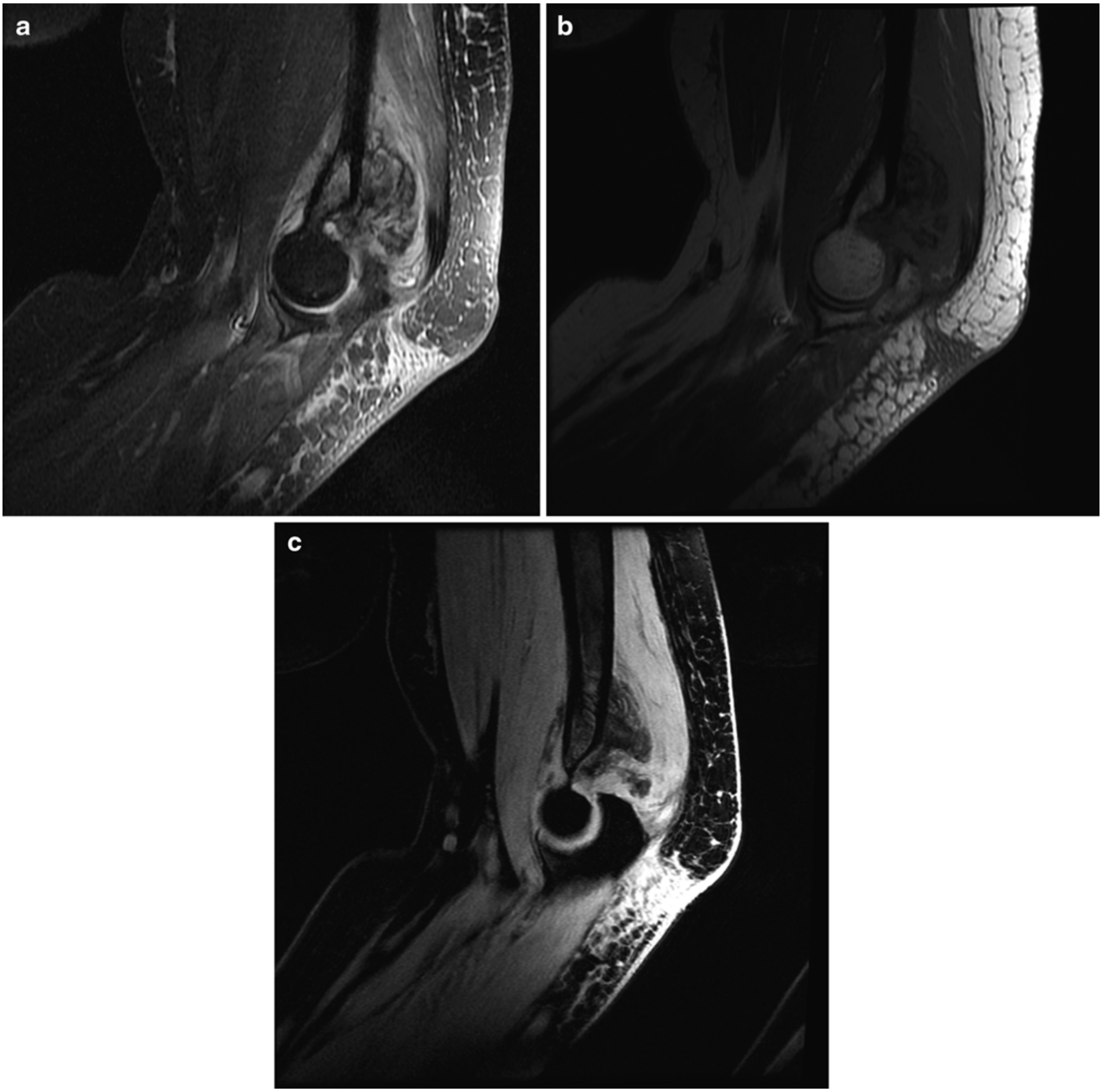

Fig. 26.19 (**a**–**c**) Sagittal T1, T2, and T2-fat-saturated MRI images showing the formation of HO in the posterior aspect of the elbow. The HO is deep to the triceps tendon, filling the olecranon fossa. This is an active process, with the development of spongy immature bone, as evidenced by edema in the bone and surrounding musculature (**a**–**c**: Published with kind permission. Copyright © Felix H. Savoie, III, MD)

Triceps Repair

Introduction

Distal triceps rupture is a rare injury, among the least frequent of tendon injuries. It is most commonly associated with anabolic steroid use, weight lifting, and traumatic laceration [18]. An eccentric load applied to a contracting triceps is the most common mechanism of injury. Ruptures can also occur spontaneously or after surgical release and reattachment [19]. Injuries to the triceps include partial and complete avulsions from the bone, intrasubstance tears, and muscle tendon junction tears. The mean age of occurrence is the fourth decade of life; however, the spectrum is wide as people continue to be more active later in life [20, 21].

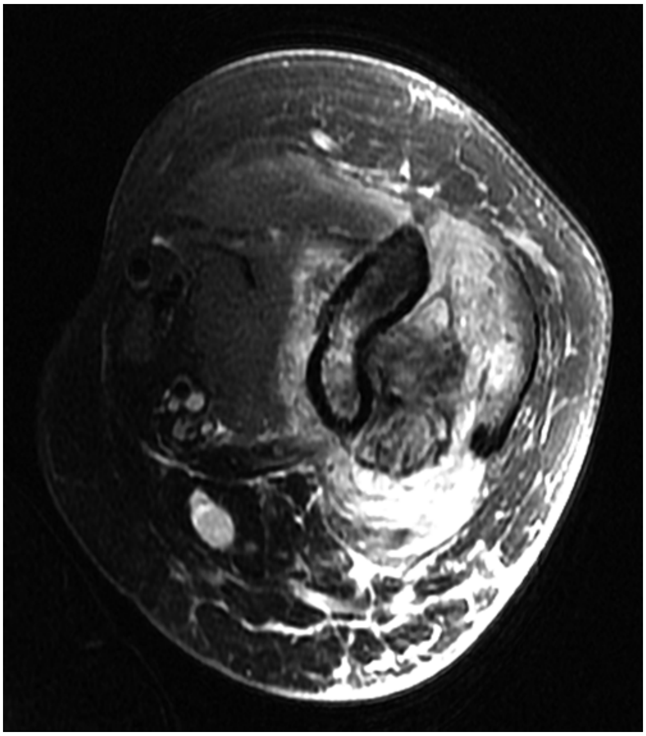

Fig. 26.20 Axial MRI image showing heterotopic bone in the posterior compartment. The HO is deep to the triceps, filling the olecranon fossa, with edema in the bone and surrounding musculature (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

Fig. 26.21 Arthroscopic image of heterotopic bone in the posterior compartment of a left elbow. The arthroscope is viewing from a posterior trans-tendon portal. The HO fills the olecranon fossa with the triceps muscle on the *upper right* of the image. The bone is very soft and spongy. It easily fragments and can be removed with a motorized shaver (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

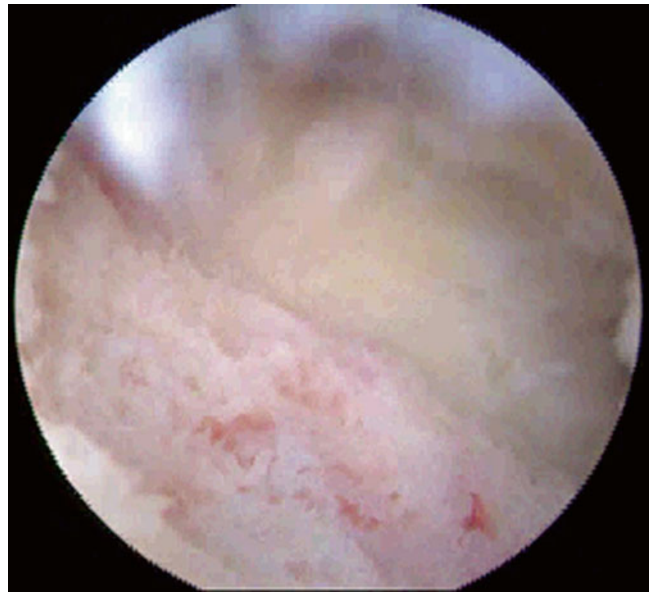

Fig. 26.22 Arthroscopic image after resection of the heterotopic bone in the posterior compartment of the elbow. The arthroscope is in a posterior trans-tendon portal. The HO has been resected, with cortical bone of the humerus at the *top* of the image (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

The history will usually describe a fall onto an outstretched arm or injury during weight lifting. Physical examination may reveal a palpable defect at the insertion of the triceps. Also, a “Thompson squeeze test” of the elbow has been described where compression of the triceps fails to create extension of a flexed elbow [20]. Partial tears may not demonstrate such a defect or positive compression test and may only be suspected when a patient has weakness in elbow extension. One of the key exam findings is a + triceps stress test. In this examination, the elbow is fully flexed, and the patient is asked to extend against resistance while the examiner palpates the distal triceps tendon. A positive test occurs when there is pain and/or a palpable defect with this maneuver. All exam findings should be compared to the contralateral side.

Imaging can be helpful in the diagnosis of distal triceps rupture. Simple radiographs may demonstrate a fleck of bone from the olecranon. MRI and ultrasound are also useful. The sagittal MRI is useful to identify the extent and location of the tear. It is important to describe the tear based on the degree of the tear (complete or partial) and/or location of the tear (muscle belly, musculotendinous junction, tendonous insertion, or avulsion). It is also important to note the integrity of the lateral expansion (intact versus torn) [18]. An intact lateral expansion in conjunction with the anconeus may be able to compensate for an otherwise torn triceps tendon.

In general, partial tears less than 50% can be treated nonoperatively with satisfactory results [22]. Partial tears greater

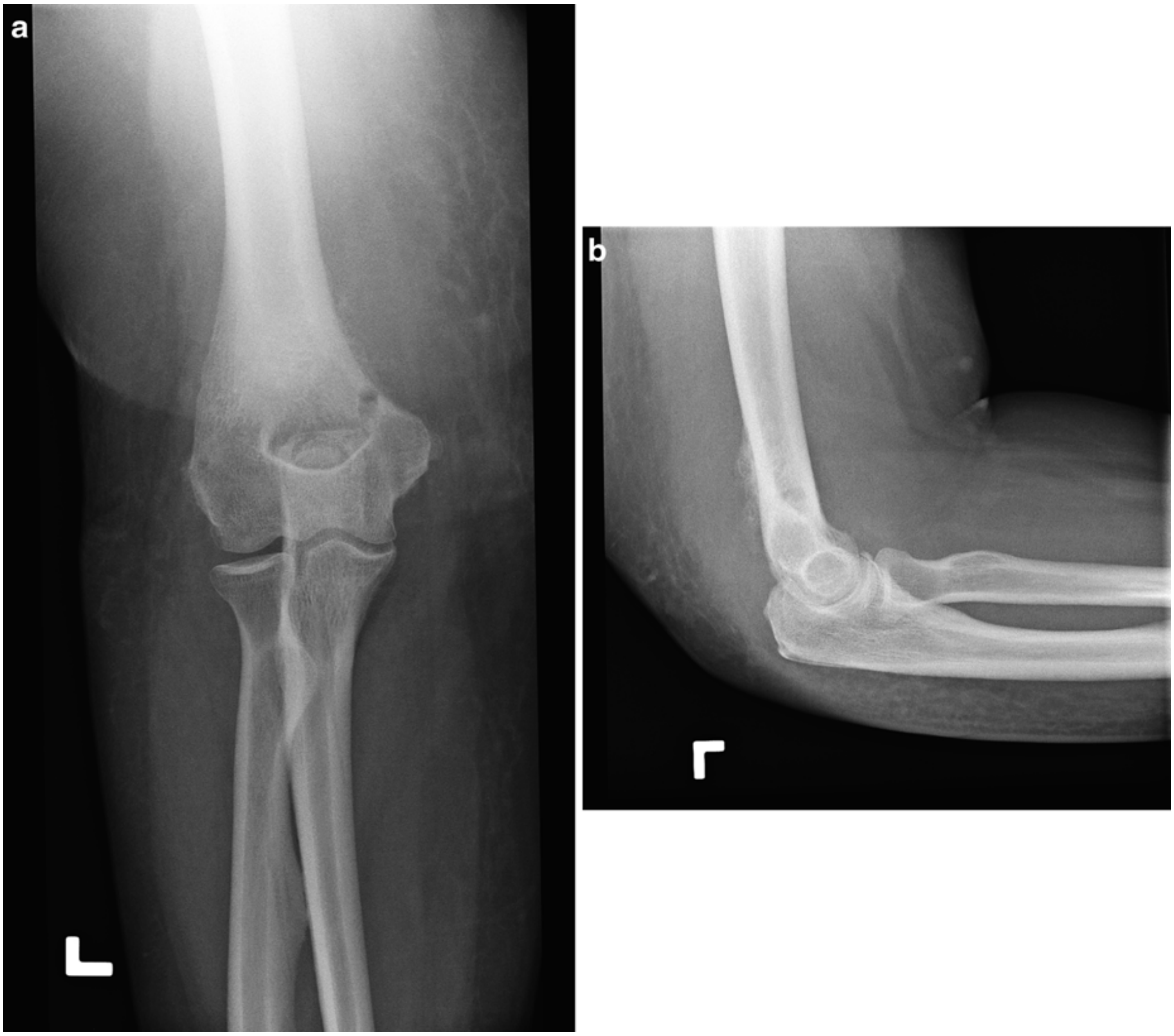

Fig. 26.23 (**a**, **b**) Postoperative AP and lateral radiograph 2 months postoperative. The HO in the posterior compartment has not recurred (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

than 50% can be treated non-operatively in sedentary individuals but may require surgery in highly active individuals [23, 24]. Complete tears are treated surgically [25].

Case 1: Distal Triceps Tear

History/Exam

A 70-year-old male who is a very active physical therapist and weightlifter presented to the clinic complaining of left elbow pain and weakness. He has a history of chronic olecranon bursitis undergoing multiple corticosteroid injections in the past. He reported a specific event where he felt a "pop" during weight lifting that prompted him to come to the clinic.

Physical examination revealed a large effusion over the olecranon. He had no erythema, full passive range of motion of the elbow, and a positive triceps stress test. Motor strength testing revealed 1/5 motor strength in elbow extension.

Imaging

Imaging, including X-ray and MRI, was performed. Figure 26.24a–c (a plain lateral radiograph and corresponding arthroscopic images) shows a fleck of bone off the tip of the olecranon and what appears to be chronic calcification of the tendon. MRI demonstrated a complete avulsion of the central portion of the tendon with intact medial and lateral bands (Figs. 26.24a–c, 26.25, 26.26, 26.27, 26.28, 26.29, 26.30, and 26.31).

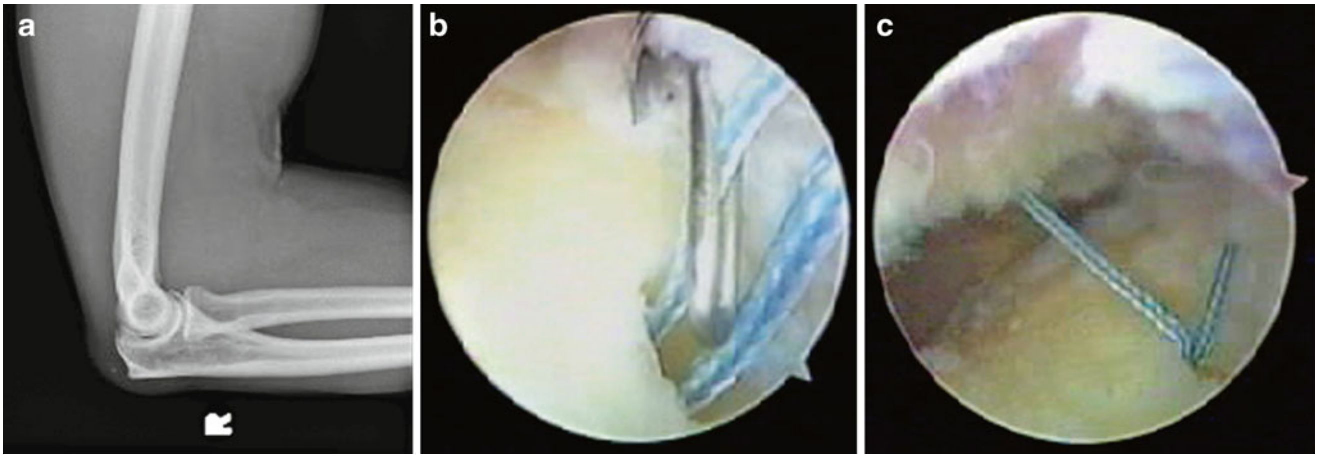

Fig. 26.24 (**a**–**c**) Lateral radiograph and corresponding arthroscopic images demonstrating mild soft tissue swelling over the olecranon and small calcific densities near the insertion of the triceps tendon (**a**–**c**: Published with kind permission. Copyright © Felix H. Savoie, III, MD)

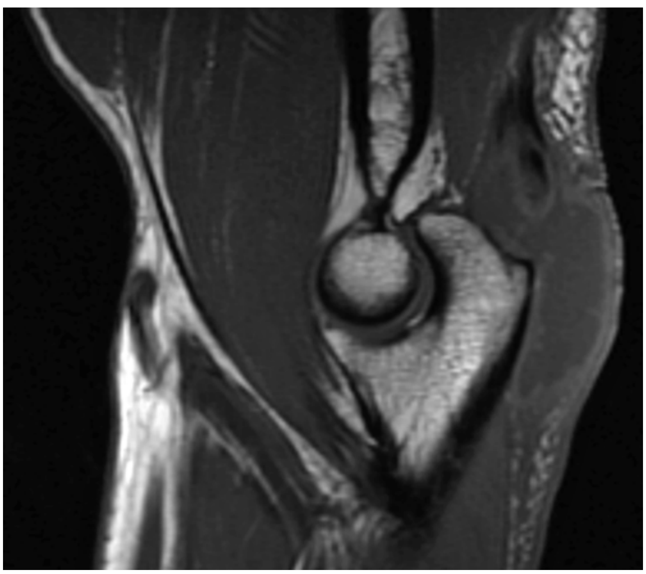

Fig. 26.25 T1-weighted sagittal view of a complete distal triceps tear (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

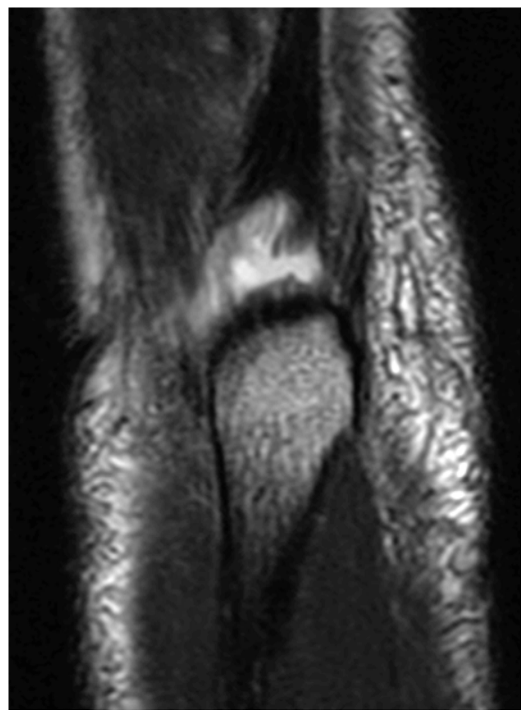

Fig. 26.26 Coronal T2-weighted MRI demonstrating complete distal triceps tear (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

The patient failed conservative treatments including injections and therapy and was unable to return to his previous activity level. Despite his older age, he was still very active and demonstrated functional limitations. Therefore, arthroscopic surgery to repair the torn triceps tendon was offered. After a lengthy discussion of treatment options and the risks and benefits of surgery, the patient consented to have the procedure performed.

Arthroscopy

The patient was placed in the prone position, and standard diagnostic arthroscopy of the anterior compartment revealed synovitis but no other pathology. The arthroscope was placed in the posterior compartment through a posterior trans-tendon portal, with motorized shaver placed through a posterolateral portal. The central portion of the triceps tendon was visualized avulsed from the tip of the olecranon. The triceps tendon was lightly debrided as well as the bone of the olecranon. A double-row triceps repair was performed, with the initial anchor placed into the tip of the olecranon. The sutures were retrieved through the triceps proximal to the tear and tied

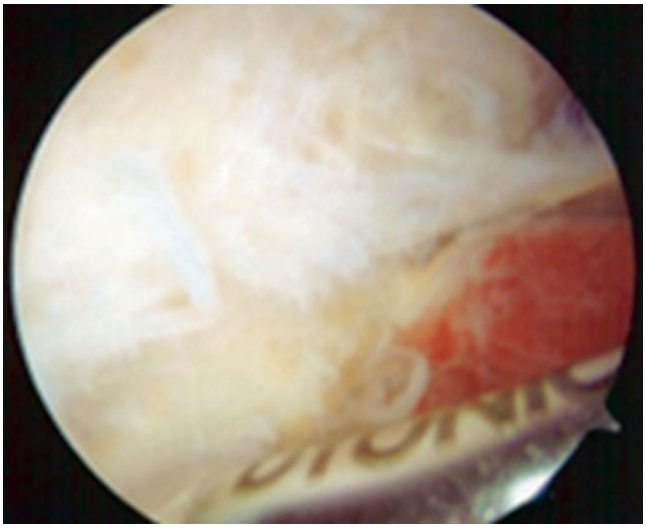

Fig. 26.27 View from the posterior portal showing the tip of the olecranon without the normal triceps attachment (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

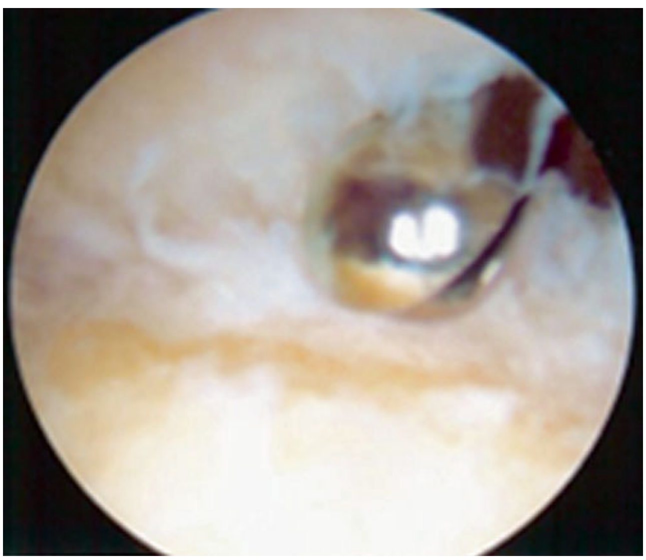

Fig. 26.28 In this view from the proximal posterolateral portal, the shaver is seen entering the elbow through the tear in the triceps. The olecranon is at the *bottom* of the picture (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

down in mattress fashion, repairing the tear to the proximal olecranon. The arthroscope was then placed into the olecranon bursa through a more distal central portal. The bursa was excised with the shaver. The limbs of the sutures were placed into a smaller knotless anchor, and the anchor was impacted into the dorsal aspect of the olecranon to complete the double-row repair. See Figs. 26.28, 26.29, 26.30, and 26.31.

The patient was placed in an elbow brace in full extension. At 1 week, the brace was set to allow 0–30 degrees of motion.

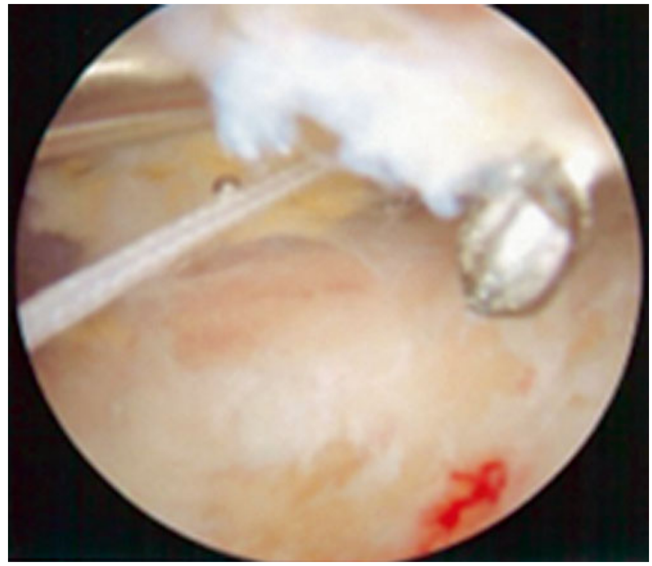

Fig. 26.29 In this view from the posterolateral portal, one suture is being retrieved proximal to the tear (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

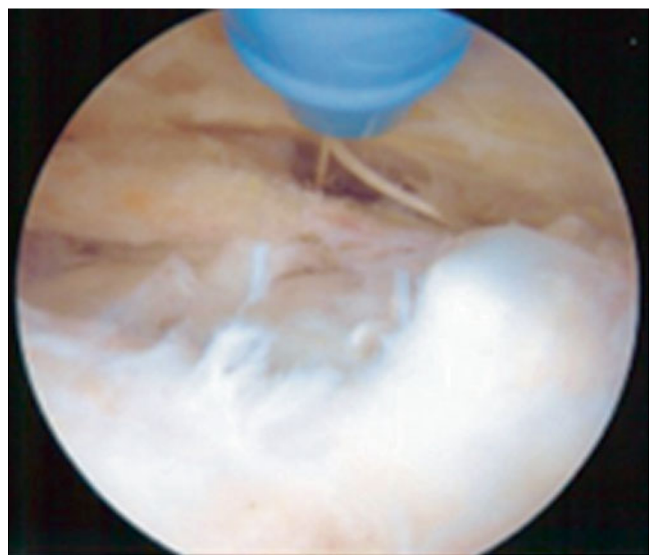

Fig. 26.30 In this view from the distal olecranon bursa portal, the tip of the olecranon is covered by proximal row repair, and the proximal sutures are seen entering the cannula (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

Ten degrees was added to the flexion each week until 90° of pain-free motion was achieved at 7 weeks postoperative. The brace was discontinued and strengthening/exercise initiated. Ten weeks postoperatively, the patient achieved a full range of motion with 80% strength recovery and had resumed both work and working out. Biodex test at 6 months showed no side-to-side strength difference.

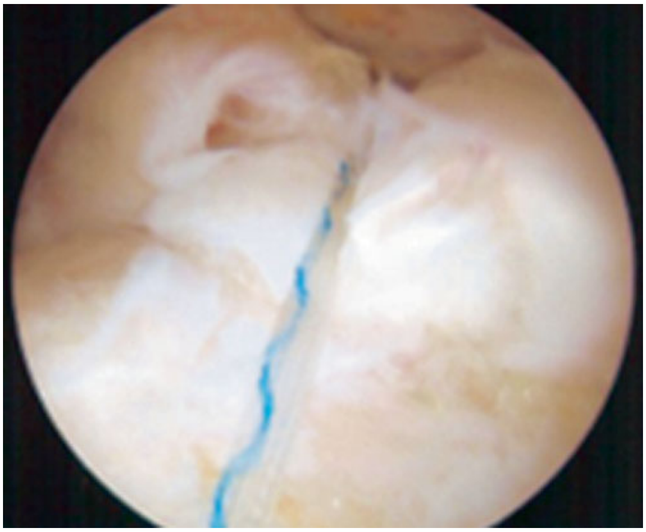

Fig. 26.31 Final view of the second part of the repair from the distal olecranon bursa portal showing the suture bridge in the center of the tendon (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

Posterolateral Plica Excision

Introduction

Posterolateral plica syndrome of the elbow is a relatively rare cause of persistent pain in the posterior and lateral aspects of the elbow. The plica is a normal synovial fold found in most elbows, but it may become inflamed and painful in certain cases. The hypertrophic synovial plica can be associated with localized synovitis and radiocapitellar chondromalacia [26]. Patients will complain of pain in the posterolateral aspect of the elbow, usually worse as the elbow goes into full extension and supination, and may experience symptoms of snapping. It is common in baseball players, gymnasts, golfers, and tennis players [27], where elbow extension, axial load, and valgus force may compress the plica and lead to synovial irritation. It has also been described as a possible pain source in the setting of recalcitrant lateral epicondylitis [28].

Physical exam may demonstrate fullness in the posterolateral gutter. Range of motion is usually full, but loss of terminal extension can occur with a 10° flexion contracture. The plica is usually palpable and tender in the posterior radiocapitellar joint. Pain with forced terminal extension is common. The lateral compression test is performed with forced terminal extension and supination, which pinches the inflamed plica between the radial head and capitellum and recreates the pain. The flexion-pronation test reproduces a snapping sensation by passively flexing a pronated arm in the range of 90–110° of flexion [26].

Conservative treatment is usually successful, beginning with rest, oral anti-inflammatory medication, activity modification, and a possible corticosteroid injection. When conservative treatment fails to provide relief, surgery for an arthroscopic resection of the plica is an option, with complete relief of symptoms in 71–92% of cases [26, 27].

Case 1: Posterolateral Plica Syndrome

History/Exam

A 41-year-old, right-hand-dominant female presented to the orthopedic clinic with a chief complaint of right elbow pain. She was an avid golfer and referred for evaluation of lateral epicondylitis. She complained of posterolateral pain in the right elbow. It initially bothered her while swinging a golf club, and she described a sharp pain with snapping on the outside of the elbow during follow-through of her golf swing. The pain became more consistent and now bothered her during activities of daily living and occasionally at night. It was exacerbated by reaching to the side and lifting objects with the forearm supinated. She was diagnosed with lateral epicondylitis and treated with three cortisone injections into the lateral epicondylar region with limited relief.

Physical examination revealed a slight fullness in the posterolateral gutter of the right elbow. She had tenderness over a palpable synovial fold in the posterior radiocapitellar joint which recreated her pain. She had full active range of motion, pain with forced elbow extension, and a positive flexion-pronation test. She had no ligamentous instability on exam, minimal tenderness over the lateral epicondyle, no pain with resisted wrist extension, and a negative Cozen's test.

Imaging

Radiographs were obtained with four views of the elbow including AP, lateral, and oblique projections. Radiographs were normal with a concentric ulnohumeral joint and no fractures or subluxations. She presented with an MRI of the right elbow without contrast. A complete sequence of images was obtained, including axial T1 and fat-saturated T2 sequences, oblique coronal fat-saturated T1 and T2 sequences, and oblique sagittal T1 and fat-saturated T2 sequences. A fat-saturated sagittal T2-weighted image is demonstrated in Fig. 26.32.

MRI revealed an inflamed posterolateral plica that extended into the posterior radiocapitellar joint with increased signal on T2-weighted images (Fig. 26.32). There was no signal intensity in the common extensor origin at the lateral epicondyle, no ligament tears, and no cartilage defects in the radial head or capitellum.

The MRI findings demonstrated an inflamed posterolateral plica, which was consistent with her physical exam. At her initial visit, she was given a corticosteroid injection directly into the posterolateral plica. This eliminated her pain

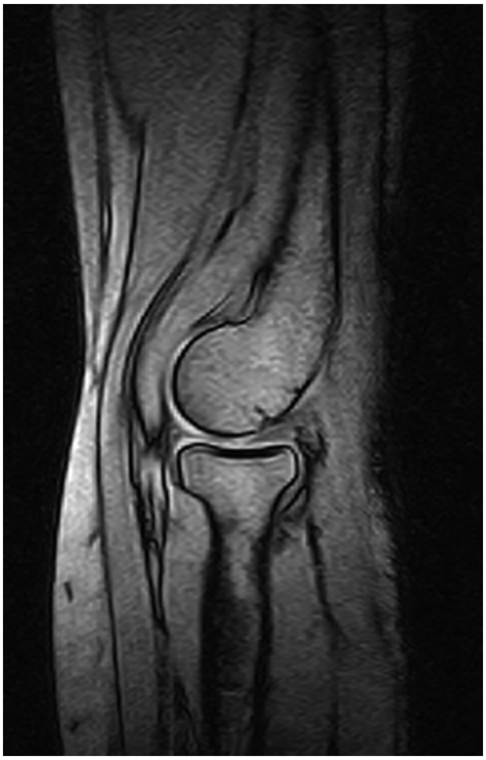

Fig. 26.32 A T2-weighted sagittal oblique MRI image demonstrates an enlarged posterolateral plica in the posterior radiocapitellar joint. Increased signal in the plica signifies inflammation and swelling (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

for 8 weeks. When the pain returned, she was offered an additional cortisone injection or surgery for an arthroscopic excision of the posterolateral plica. After an extensive discussion with the patient, she elected to proceed with the proposed surgical intervention.

Arthroscopy

The patient was taken to the operating room and placed in the prone position with the operative arm placed on a bump over an arm board. A pneumatic tourniquet was used for the case. A standard diagnostic arthroscopy of the anterior compartment was completed with no pathologic findings. The arthroscope was then placed into the posterior compartment through a posterior trans-tendon portal. The arthroscope was advanced down the posterolateral gutter. An inflamed plica was visualized in the posterolateral gutter (Fig. 26.33). A lateral soft portal was established with a spinal needle, and the plica was excised with a motorized shaver. After plica excision, she was noted to have a small area of chondromalacia on the posterior aspect of the radial head (Fig. 26.34). No full thickness cartilage defects were identified, and a microfracture was not performed.

The patient began therapy at 1 week postoperatively and had regained full motion by 3 weeks postoperatively. Physical therapy was initiated, along with return to golf program. The patient resumed play at 6 weeks post-surgery with no limitations.

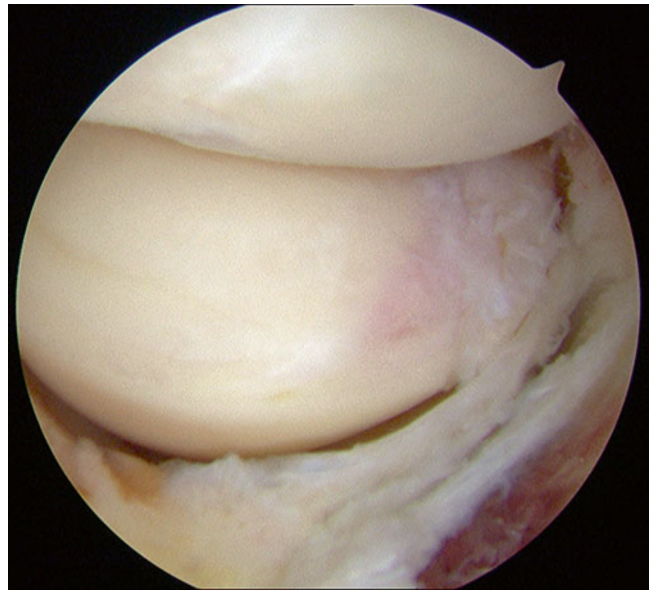

Fig. 26.33 An arthroscopic view of the posterolateral gutter in a right elbow with the arthroscope in a posterior trans-tendon portal. An enlarged posterolateral plica is visualized on the *right* of the image, projecting into the radiocapitellar joint (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

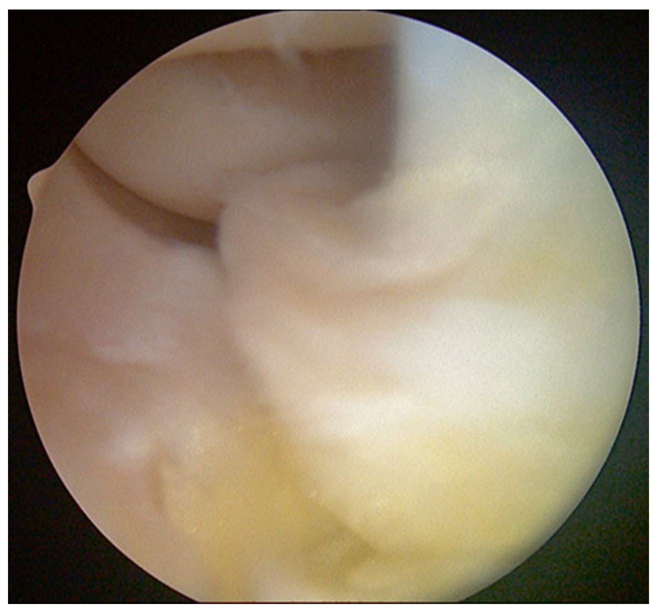

Fig. 26.34 The same view after resection of the plica. The annular ligament is intact coursing around the radial head. There is chondromalacia on the posterior aspect of the radial head (Published with kind permission. Copyright © Felix H. Savoie, III, MD)

References

1. O'Driscoll SW, Bell DF, Morrey BF. Posterolateral rotatory instability of the elbow. J Bone Joint Surg Am. 1991;73(3):440–6.
2. Smith JP, Savoie FH, Field LD. Posterolateral rotatory instability of the elbow. Clin Sports Med. 2001;20(1):47–58.
3. Kalainov DM, Cohen MS. Posterolateral rotatory instability of the elbow in association with lateral epicondylitis. A report of three cases. J Bone Joint Surg Am. 2005;87(5):1120–5.
4. Melhoff TL, Noble PC, Bennett JB, Tullos HS. Simple dislocation of the elbow in the adult: results after closed treatment. J Bone Joint Surg. 1988;70:244–9.
5. Stoneback JW, Owens BD, Sykes J, Athwal GS, Pointer L, Wolf JM. Incidence of elbow dislocations in the United States population. J Bone Joint Surg Am. 2012;94:240–5.
6. Regan W, Lapner PC. Prospective evaluation of two diagnostic apprehension signs for posterolateral instability of the elbow. J Shoulder Elbow Surg. 2006;15(3):344–6.
7. Hardy AG, Dickson JW. Pathological ossification in traumatic paraplegia. J Bone Joint Surg Br. 1963;45:76–87.
8. Viola RW, Hastings H, 2nd. Treatment of ectopic ossification about the elbow. Clin Orthop Relat Res. 2000;(370):65–86.
9. Baird EO, Kang QK. Prophylaxis of heterotopic ossification—an updated review. J Orthop Surg Res. 2009;4:12.
10. Dodds SD, Hanel DP. Heterotopic ossification of the elbow. In: Tumble TE, Budoff JE, editors. Master skills: wrist and elbow arthroscopy and reconstruction. Rosemont, IL: American Society for Surgery of the Hand; 2006. p. 425–38.
11. Crawford CM, Barghese G, Mani MM, et al. Heterotopic ossification: are range of motion exercises contraindicated? J Burn Care Rehabil. 1986;7(4):323–4.
12. Peterson SL, Mani MM, Crawrord JR, et al. Post-burn heterotopic ossification: insights for management decision making. J Trauma. 1989;29(3):365–9.
13. Evan EB. Heterotopic bone formation in thermal burns. Clin Orthop Relat Res. 1991;263:94–101.
14. Nollen AJ. Effects of ethylhydroxydiphosphonate (EHDP) on heterotopic ossification. Acta Orthop Scand. 1986;57(4):358–61.
15. Hurvitz EA, Mandac BR, Davidoff G, et al. Risk factors for heterotopic ossification in children and adolescents with severe traumatic brain injury. Arch Phys Med Rehabil. 1992;73(5):459–62.
16. Stein DA, Patel R, Egol KA, et al. Prevention of heterotopic ossification at the elbow following trauma using radiation therapy. Bull Hosp Jt Dis. 2003;61(3–4):151–4.
17. Garland D. A clinical perspective on common forms of acquired heterotopic ossification. Clin Orthop Relat Res. 1991;263:13–29.
18. Yeh P, Dodds S, Smart L, Mazzocca A, Sethi P. Distal triceps rupture. J Am Acad Orthop Surg. 2010;18:31–40.
19. Bauman GI. Triceps tendon rupture. J Bone Joint Surg. 1934;16:966–7.
20. Viegas SF. Avulsion of the triceps tendon. Orthop Rev. 1990;19(6):533–6.
21. Clayton ML, Thirupathi RG. Rupture of the triceps tendon with olecranon bursitis: A case report with a new method of repair. Clin Orthop. 1984;184:183–5.
22. Vidal AF, Drakos MC, Allen AA. Biceps tendon and triceps tendon injuries. Clin Sports Med. 2004;23:707–22.
23. Mair SD, Isbell WM, Gill TL, Schegel TF, Hawkins RJ. Triceps tendon ruptures in professional football players. Am J Sports Med. 2004;32:431–4.
24. Straunch RJ. Biceps and triceps injuries of the elbow. Orthop Clin North Am. 1999;30:95–107.
25. Van Riet RP, Morrey BF, Ho E, O'Driscoll SW. Surgical treatment of distal triceps ruptures. J Bone Joint Surg Am. 2003;85:1961–967.
26. Antuna SA, O'Driscoll SW. Snapping plicae associated with radiocapitellar chondromalacia. Arthroscopy. 2001;17(5):491–5.
27. Kim DH, Gambardella RA, Elattrache NS, Yocum LA, Jobe FW. Arthroscopic treatment of posterolateral elbow impingement from lateral synovial plicae in throwing athletes and golfers. Am J Sports Med. 2006;34(3):438–44.
28. Ruch DS, Papadonikolakis A, Campolattaro RM. The posterolateral plica: a cause of refractory lateral elbow pain. J Shoulder Elbow Surg. 2006;15(3):367–70.