Sports-related Injuries of the Elbow

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Sports-related Injuries of the Elbow

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ABSTRACT: Sports-related injuries about the elbow occur commonly and are often managed by a wide variety of health care providers. It is particularly important that a surgeon well versed in arthroscopy, reconstructive trauma, and peripheral nerve techniques evaluates potentially complex injuries. It is equally imperative that the preoperative care regimen and postoperative management be conducted by an experienced therapist who understands elbow biomechanics and function. Acute pathology, such as fracture or severe ligamentous and tendinous injury, usually warrants operative treatment. A thorough understanding of the anatomy and biomechanics of the elbow is crucial since the expected recovery in the nonathlete will not suffice for the competitive athlete. Demanding activities, such as the overhead-throwing motion cycle, require a much more complete recovery than simple return to activities of daily living. Chronic elbow problems in the athlete can often be managed with appropriate therapy and modification to the training protocol. Poor response to conservative means should lead to a more thorough evaluation by an experienced elbow surgeon as these injuries can often be career ending. The spectrum of commonly seen lesions in the athlete’s elbow is described here, as are conservative care measures, operative treatments, and postoperative management.


The elbow remains a crucial link to the athlete’s hand in that it places the hand in space in order to perform its key function in athletic activity. Therefore, it is important to treat the elbow adequately; otherwise, hand function will be impaired. Elbow injuries are typically seen in throwing athletes but can also occur in athletic disciplines that require lifting, pushing, pulling, or transfer of force to a racquet or other piece of sporting equipment. Elbow pathology is often treated by the sports medicine specialist, the hand and upper extremity surgeon, or even the general orthopedic surgeon. In the case of athletes, many of the lesser injuries are initially handled and triaged by the athletic trainer or team therapist, although the definitive diagnosis may not be made until a later stage. The therapist, as the director of the conservative care regimen as well as postoperative management, is a critical member of this team. Effective communication among the physician, therapist, trainer, and athlete is imperative to ensure successful outcomes. Although several common acute sports injuries will be discussed in lesser detail in this paper, the emphasis will be on sport-specific chronic injuries.

CLINICAL ANATOMY AND PATHOMECHANICS OF ELBOW ATHLETIC INJURIES

The chronic injuries associated with overuse can be a result of either intrinsic or extrinsic mechanisms. We describe intrinsic mechanisms as those that are essentially tendinitis or associated inflammatory problems that result from a repetitive force of muscular contraction leading to microtrauma to the soft tissues involved. Extrinsic mechanisms involve external forces being applied to the elbow that cause injury over the long term. Extrinsic overuse can be from excessive torque with tension upon the soft tissues as seen, for example, in ulnar collateral ligament injuries of the throwing athlete or compression injuries such as impingement that can be seen in the posterior elbow or in the radiocapitellar joint during those same mechanisms. The injuries that are seen in overhead-throwing athletes are good examples of sports-specific chronic
injuries. Certain injuries, such as ulnar collateral ligament attenuation, are almost only seen as a result of this type of unnatural stress to the elbow. Lateral epicondylitis, which is frequently associated with racquet sports or gymnastics, can lead to hyperextension-type chronic injuries in the elbow. The overhead motion made to throw a baseball, football, or javelin is perhaps the most well-understood athletic skill in regard to the elbow joint. This act requires a very precise sequence of events in order to propel the object with force and athletic precision. The considerable forces exerted on the elbow during the overhead-throwing motion lead to a very broad spectrum of injuries often termed “valgus extension overload syndrome.” This encompasses medial tension upon the elbow causing ligamentous injury as well as lateral compression, which can cause injury to the radiocapitellar joint. This can also lead to posterior impaction injury to the elbow. This diffuse injury not only requires the appropriate diagnosis, but necessitates the institution of analysis of throwing mechanics and preventive measures to minimize the chance of progressive injury.

Chondromalacia, loose bodies, and osteochondritis dissecans (OCD) are several chronic or overuse pathologies that are frequently seen in the athlete’s elbow. These conditions all involve the articular surface, but we can also see overuse injuries in the lateral collateral ligament (LCL) complex as well as in the surrounding nerve structures, most commonly the ulnar nerve within the cubital tunnel. The flexor or extensor musculotendinous origin can also be affected with a chronic degenerative process, and these common entities will be individually discussed in a later section of this paper. Acute injuries that are discussed include fractures, most commonly of the radial head or olecranon, as well as acute ligamentous injuries such as complete elbow dislocations or limited ligamentous avulsions that require immediate treatment.

Regardless of whether the injury is chronic or acute, the physician, therapist, and trainer must understand elbow biomechanics as well as the specific needs of the athlete in his or her sport. The patient’s goals and expectations must be further assessed prior to the start of the rehabilitation program and choice of surgical intervention, if needed. The goal of rehabilitation is to return the athlete to his or her pre-injury status; therefore, strength, endurance, and flexibility must be addressed.

**CHRONIC INJURY AND MANAGEMENT**

**Ligament Injury**

The medial collateral ligament complex has been a focus of study for many years. The anterior bundle of the medial collateral ligament of the elbow is the most important stabilizer on the medial side. This medial ligamentous complex is often injured in the throwing athlete and remains one of the most classic sports injuries seen in the elbow joint. It is becoming apparent that the lateral complex plays an equally significant, if not more important, role in stability. The lateral ulnar collateral ligament is the most important structure on the lateral side of the elbow, and it prevents posterolateral rotatory instability.

The skeletally immature athlete is much more prone to throwing injuries. Adequate periods of rest and recovery are crucial in allowing the young athlete to continue his or her career. These common injuries are termed “little league elbow,” a very general term describing the painful elbow pathology occurring as a result of the repetitive throwing motion. Brogdon and Crow coined this term to describe the most common roentgenographic criteria in the elbow pathology of young pitchers. The syndrome can include a variety of injuries such as OCD of the capitellum or radial head, medial epicondyle apophysitis, and even complete fracture as well as anterior capsular injury and olecranon trauma. All of these injuries occur as a result of excessive valgus stress and hyperextension. A whole spectrum of different injuries is seen in the adult athlete.

**Conservative Management**

As in other chronic elbow disorders, nonoperative treatment is the first line of treatment in throwing injuries of the elbow. This can include treatment for ulnar neuritis as well as ulnar collateral ligament strain or even epicondylitis. The rehabilitation program includes the modalities for pain control and tissue healing that are often used in nonathletic injuries. The program, though, must encompass sport-specific activities such as interval-throwing programs as well as strengthening and endurance sport–specific activities.

**Operative Management**

Because many of these injuries occur insidiously over time, arthroscopy has been invaluable in being able to detect and treat these lesions at a much earlier stage and, hence, institute treatment. The procedure carries minimal morbidity as seen in other joints and allows a much more rapid return to competition. Once the tissue damage has progressed, such as with a severe ulnar collateral ligament injury, open surgical procedures are often necessary.

The classic sport-specific procedure for the elbow has been popularly referred to as the “Tommy John surgery” and consists of ulnar collateral ligament reconstruction typically using the palmaris longus tendon graft. The surgeon must have a thorough understanding of the normal biomechanics of the elbow as well as the excessive forces applied to this joint.
during athletic activity when planning and carrying out repair or reconstruction. It has been estimated that the ulnar collateral ligament has a static demand of 35 Newton meters during the pitching motion. Biomechanical studies have shown that the ultimate tensile strength of the ulnar collateral ligament is approximately 33 Newton meters. Therefore, the demand on the ulnar collateral ligament must be buffered by the stability and strength provided by the flexor-pronator muscle origin. This is one example of why conditioning of the flexor-pronator muscles is so critical in this particular athletic motion.

**Epicondylitis/Epicondylosis**

Epicondylitis is the most frequent cause of pain in the elbow, presenting either laterally or medially. This common problem may be seen in athletes and non-athletes and had been reported to be at least ten times more frequent laterally than medially. It seems much more likely that certain patients have a predisposition to this overuse syndrome, and it can be exacerbated by certain sports activities such as racquet sports or even golf. Lateral epicondylitis has been commonly termed as “tennis elbow” and medial epicondylitis as “golfer’s elbow,” although these entities are often seen in the general nonathletic population.

At the Miami Hand Center, the majority of patients with this entity are either perimenopausal women or middle-aged male laborers. Changes in estrogen levels in women may be a predisposing factor for perimenopausal women to thickening of the tenosynovium around the tendons as seen in other common problems such as flexor tenosynovitis and even carpal tunnel syndrome. This phenomenon is little understood, while the lay press continues to assign an etiology of so-called repetitive motion disorders. At the time of this writing, we are not aware of scientific studies that have substantiated this notion.

Similar to athletes, heavy laborers frequently develop epicondylitis that is exacerbated by heavy and repetitive use of the elbow. This presentation does occur in women, but in our society, males still tend to dominate the majority of intense physical labor occupations. Athletes tend to be very compliant and motivated with therapy programs; in spite of this, modalities directed at decreasing inflammation of the extensor or flexor origin have shown inconsistent results. In the athlete, epicondylitis is often caused by repetitive stress and strain to the forearm and wrist musculature from incorrect equipment or technique, as well as a sudden change in activity or intensity.

**Lateral Epicondylitis**

Conservative Management. Conservative management includes the use of oral and topical nonsteroidal anti-inflammatory medications, counterforce bracing to reduce the forces to the damaged tendons, and pain-relieving techniques. The athlete is instructed in massage in a clockwise, counterclockwise fashion along and perpendicular to the extensor muscle mass to be done twice per day.

At approximately three weeks following initiation of therapy, gentle, pain-free range of motion (ROM), active stretching exercises are performed to gradually restore the flexibility of the muscles around the elbow. These exercises are performed with the elbow flexed, elbow extended, forearm supinated then pronated, and wrist flexed and extended for 20 repetitions two to three times per day. These are progressed to passive stretching exercises and then strengthening exercises for four to six weeks. The patient should feel a stretch but not pain. Once the athlete is pain free, graded progressive isometric exercises are started initially, with the elbow partially flexed and forearm supinated. They are progressed to concentric exercises starting slowly with 1 lb weight or light resistive tubing and increasing as tolerated by the patient (Figures 2A and 2B). High repetitions such as 25–40 should be performed once to twice per day.

Strengthening exercises are progressed to eccentric muscle training. Progression to isokinetic exercises occurs once the athlete can tolerate isotonic exercises for the wrist and elbow motion. For example, in the initial therapy program, the forearm is supinated during the wrist extension–flexion training. After some time, as the strength improves, the patient is asked to progress to forearm-pronated training because of the additional work required against gravity.

Progressively escalating the level of play with the sporting activity is important to avoid re-injury. (Table 1 summarizes management of lateral

![FIGURE 1. Iontophoresis with dexamethasone applied along the ECRB muscles to address pain.](Image)
Equipment parameters, such as size, grip, and force, should be optimal for that particular athlete. Proper body mechanics and sport movements should be monitored to prevent recurrence of symptoms. It is also important to ensure that proper conditioning, warm-up, stretch, equipment, and techniques are used for the specific sport for each athlete. Specific suggestions regarding tennis technique and equipment are given in Table 2. The patient should understand that in most cases, this painful syndrome will “burn itself out” with proper conservative care and modifications to sports-related training programs.

Operative Treatment. Operative treatment is reserved for recalcitrant cases and is usually directed at removing the inflammatory focus at the tendon origin. The classic procedure, first described by Nirschl, involves excising the area of angiofibroblastic tissue that is within the origin of the extensor carpi radialis brevis tendon and then decorticating the lateral epicondyle to stimulate healing. Baker et al. have now performed the same procedure arthroscopically in order to minimize weakness of the extensor origin and provide pain relief. We have found that this technique provides superior results with rapid incorporation into sports training. We have also used this approach with excellent results in recurrences from the open procedure.

Plasma-mediated radiofrequency ablation of the extensor origin is a newer technique that uses radiofrequency waves to generate heat for tissue ablation and consequently stimulate blood flow for healing as a reparative response. An initial clinical study by Tasto et al. demonstrated excellent results in 13 patients through two years following the procedure; however, evaluation of this approach in a larger cohort is necessary. The principal advantage is that the recovery phase is rapid and the surgery minimally invasive, allowing for it to be performed only under local anesthesia. Ongoing studies will determine if this novel technique will be added to the standard treatment armamentarium. The ease of recovery has allowed one of the authors (AB) to offer this option at an earlier time to patients with a recalcitrant course of symptoms.

Postoperative Rehabilitation Program. The progression of rehabilitation following lateral epicondylitis surgery is determined on the basis of the type of surgical technique. After open surgical procedure, the elbow is immobilized in a posterior splint in 90° flexion, forearm in neutral, and wrist in 30° extension for approximately five to seven days. After this time, active ROM exercises for the elbow, forearm, and wrist through a pain-free ROM are initiated. This then progresses to stretching exercises and then to resistive exercises.

The arthroscopic technique requires no splinting, and we begin rehabilitation two to three days following surgery, using only an ace bandage wrap for protection. A similar protocol is used after plasma-mediated radiofrequency ablation (Topaz technique), although wound monitoring and care is done if necessary. Pain-relieving modalities are used only as needed. ROM exercises are initiated first...
TABLE 1. Management of Lateral Epicondylitis

<table>
<thead>
<tr>
<th>Phase 1</th>
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<tbody>
<tr>
<td><strong>Goal:</strong> decrease pain and inflammation</td>
</tr>
<tr>
<td><strong>Moderations</strong></td>
</tr>
<tr>
<td>Elbow flexion, forearm supination/pronation, wrist flexion/extension</td>
</tr>
<tr>
<td>Elbow extension, forearm supination/pronation, wrist flexion/extension</td>
</tr>
<tr>
<td>Use counterforce bracing at all times</td>
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<table>
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<tr>
<th>Phase 2</th>
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<tbody>
<tr>
<td><strong>Subacute phase passive stretching</strong></td>
</tr>
<tr>
<td><strong>Goal:</strong> increase flexibility through passive stretching</td>
</tr>
<tr>
<td><strong>Modifications</strong></td>
</tr>
<tr>
<td>Continue as needed from above</td>
</tr>
<tr>
<td>Ice after activities for 10 minutes</td>
</tr>
<tr>
<td><strong>Exercises</strong></td>
</tr>
<tr>
<td>Controlled concentric and eccentric exercises with low weight and high repetitions</td>
</tr>
<tr>
<td>Increase weight as strength increases</td>
</tr>
<tr>
<td>Avoid excessive gripping activities</td>
</tr>
<tr>
<td>Continue with use of counterforce bracing but mainly with activities</td>
</tr>
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<table>
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<tr>
<th>Phase 3</th>
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<tbody>
<tr>
<td><strong>Final stage return to sport</strong></td>
</tr>
<tr>
<td><strong>Focus on strengthening, flexibility, and endurance activities</strong></td>
</tr>
<tr>
<td><strong>Alter sport movements and mechanics to prevent the recurrence of the symptoms</strong></td>
</tr>
<tr>
<td><strong>Decrease the use of the counterforce bracing</strong></td>
</tr>
<tr>
<td><strong>Use ice as needed</strong></td>
</tr>
<tr>
<td><strong>Gradual return to sport</strong></td>
</tr>
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with elbow flexed, forearm supinated, and wrist flexed and extended. They are then progressed to elbow extended, forearm pronated, and wrist flexed and extended. These exercises are then graded to passive stretching in the same positions. The athlete should feel a stretch with these exercises, but not pain that persists after the stretch. If scar is problematic, this should be addressed.

The resistive program is initiated at approximately four weeks starting with isometrics for the elbow and wrist flexors and extendors, and forearm rotators. Progression to concentric and eccentric exercises follows, though caution is taken to ensure that the strengthening phase does not begin until pain has completely resolved.15 If pain does not completely resolve, focus continues on distal and proximal musculature strengthening along with the continued use of pain-relieving modalities such as iontophoresis11 with dexamethasone and modification of activity. There is usually a gradual return to sports about three to four months.22,23

Specific sport considerations such as performing interval training, by alternating days of activities allowing rest, are important. For example, the tennis player can start with the backhand stroke, then lobs, and gradually progress with the forehand stroke and then the serve to full play.10 Tight gripping of the racquet and hitting with the forearm pronated are avoided, and the lower extremities should be used for more force.

Medial Epicondylitis

 Conservative Management. In our experience, most persons with this condition improve with corticosteroid injection as well as therapy. Therapy management involves modalities similar to those used for lateral epicondylitis, as well as a focus on flexor-pronator strengthening.8,19 The athlete would then progress through the throwing technique phases of rehabilitation. Exercises progress from isometrics to eccentrics and concentrics once the athlete is able to gain the flexibility, strength, and endurance required for the activity.24

Operative Treatment and Postoperative Rehabilitation Program. Surgery is reserved for recalcitrant cases and consists of excision of a small portion of the prominent medial epicondyle and the inflamed portion of the flexor tendon origin.25 This procedure is performed open due to the proximity of the ulnar nerve. This condition can also be treated using the plasma-mediated radiofrequency–based approach. Postoperative rehabilitation is also similar to that of lateral epicondylitis with an emphasis on the flexor-pronator muscles. The return to the sporting activities occurs in three to four months.24

Biceps/Triceps Tendinitis

Biceps Tendinitis

Tendinitis at the distal insertion of either the biceps or the triceps tendon usually follows an acute episode where the patient can specifically remember the moment of injury. Biceps tendinitis is much more common than on the extensor aspect and can often be an antecedent condition before complete or partial biceps tendon rupture. This is one of the reasons for early treatment, e.g., when symptoms are first present. Biceps tendinitis is most commonly seen in sports such as gymnastics, weight lifting, bodybuilding, throwing, and rock climbing. It usually results from a direct blow or injury or from a
sudden increase in the intensity of activity. The symptoms are usually increased with resisted flexion and supination of the elbow. The patient's ROM is usually normal, though it may be painful to perform throughout this range.

Conservative Management. Conservative therapy is directed at resting the involved tendon to allowing healing. A splint is used with the elbow in 90° flexion and with the forearm in a neutral position for approximately three weeks. Pain-relieving modalities such as iontophoresis coupled with dexamethasone, ultrasound to the damaged tissue, and electrical stimulation are used to increase circulation and tissue extensibility. Soft tissue mobilizations to decrease soft tissue restrictions, and friction massage are used to decrease muscle tension and guarding, and are also used if needed. Progressive resistive exercises are initiated when pain levels have decreased significantly, at approximately eight weeks, starting with isometrics for the biceps and triceps musculature, progressing to concentric and eccentric exercises.

Operative Treatment. Imaging studies, such as magnetic resonance imaging, are often necessary to determine the integrity of the tendon, and an impending rupture of the bicep tendon should be treated by surgical debridement and repair as if it were a surgical tear.

TABLE 2. Tennis Tips to Reduce Injuries and Help for Return to Play

- Perform proper warm-up and stretches prior to and after play. Cardiovascular exercises and slow gentle wrist and forearm stretches
- It is important to strengthen and condition the muscle for the high demand of the sport
- Play on alternate days when possible
- Technique issues
  - Grip size: The correct grip size as described by Nirschl includes measuring the length from the distal tip of the small finger to the proximal palmar crease. In addition, the grip size is measured by fitting the index finger of the nonhitting hand between the ring finger and the palm (see Figure 3). A handle that is too small increases the load on the elbow and causes muscle fatigue. A handle that is too large limits the wrist snap while serving and causes difficulty when changing grips throughout play.
  - Proper strokes: Use body weight and trunk rotation to supply the power through the stroke and not the elbow muscles. Hit the ball in the sweet spot, the center of the racquet for ideal contact. Keep the elbow close to the body during ball contact to decrease the torque on the body. On performing the backhand stroke, avoid flexing the wrist on impact and with the serve avoid aggressively pronating the forearm (see Figure 4). Avoid maintaining a sustained grip only tighten grip on impact (see Figure 5).
- Equipment issues
  - Grip: Add a cushioned grip to prevent slippage of the racquet
  - Racquet: A medium flexible frame (95–110 square inches) in graphite to minimize vibration and shock throughout the arm is recommended.
  - Strings: String should be of 16 gauge with low and soft tension of 52–55 lb instead of tight stringing. It is important to restrung every six months
  - Tennis balls: Newer tennis balls should be used to lessen impact and force
  - Vibration dampeners: Change and absorb the sound of the impact vibration but do not minimize shock

FIGURE 3. Proper grip size demonstrating index finger fit between middle finger and palm.

FIGURE 4. Demonstration of the relax grip used while waiting for ball contact.
were an acute lesion. One author (AB) of this article has personally used low-intensity pulsed ultrasound to heal a chronic painful bicipital tendinitis. This technology (Exogen Smith & Nephew, Memphis, TN) is normally reserved for the healing of non-unions or difficult fractures. All of these modalities are aimed at increasing the blood supply to heal the tendon.

Postoperative Rehabilitation Program. Postoperative therapy involves the use of a posterior elbow splint in 90°, with the forearm in supination, for continued wear for up to six weeks. Active ROM to the non-involved structures is performed during this period of time. At four weeks, passive elbow flexion is performed along with active elbow extension to 30°. Gentle forearm supination and pronation is performed three to four times per day for 20 to 30 repetitions.

At six weeks, the splint is discontinued and active protected elbow extension is performed. At approximately 7.5 to eight weeks, active assisted and passive ROM exercises are performed for elbow extension and light strengthening is initiated. Strengthening is initiated with isometrics and then concentrics with 1 lb and rubber tubing. At approximately 10–12 weeks, eccentric strengthening is performed focusing on building strength and endurance for the entire upper extremity. Exercises for both biceps and triceps strengthening using cables are an important tool to assist the athlete through this process (Figures 6A and 6B). This treatment is then followed by the incorporation of a sport-specific exercise regimen, with return to the specific sport in approximately four to six months.

For the athlete returning to sports such as weight lifting and bodybuilding, warm-up and stretch bicep and triceps, and forearm and wrist stretches prior to practice or competition is encouraged. Cardiovascular fitness is emphasized to prevent further re-injury. The athlete is instructed on the importance of rest and recovery between practices and competition to ensure proper techniques with body

**FIGURE 5.** Pronation motion performed during the serve.

**FIGURE 6.** Use of cables for biceps (A) and triceps (B) strengthening.
Triceps Tendinitis

Conservative Management. Triceps tendinitis is seen almost exclusively in males and observed in throwing athletes or bodybuilders. It is also observed primarily with sports that require quick triceps contraction, such as off-road mountain biking, motorcycle riding, and jumping. Distal triceps tendinitis is characterized by tenderness at the insertion of the triceps muscle, and pain is exacerbated with active or resisted elbow extension. The modalities used to conservatively care for biceps tendinitis are effective in triceps tendinitis. Most patients are treated conservatively with splinting the elbow in 45° flexion, oral anti-inflammatories, pain-relieving modalities, avoidance of the aggravating activities, and rest.

For both distal biceps and triceps, corticosteroid injection is contraindicated as this can cause premature tendon rupture.

Operative Treatment and Postoperative Rehabilitation Program. The presence of an olecranon traction spur has been associated with higher failure rates for conservative treatment and may be an indication to debride the tendon and excise the spur.

Postoperative management includes splinting the elbow in 45° flexion for approximately three weeks followed by a program of graded ROM exercises, which include assisted active ROM and passive elbow extension initiated three to four times per day with 25–35 repetitions. Active ROM exercises for the elbow are performed increasing with 20–30° each week. The splint is discontinued at about six weeks, and the athlete performs both active and passive ROM for all planes.

Resistive exercises are initiated with isometrics for biceps, triceps, and distal and proximal musculature.

Concentric exercises with dumbbell weight for triceps extension are initiated and progress to overhead activities. Exercises using elastic band tubing for the forearm and wrist, gripping exercises with a tennis ball, and extension exercises with a thick rubber band for the hand are also performed. For example, with the bodybuilder, the athlete starts with light resistance (e.g., lowest-resistance elastic band) and progresses to the heavy-resistance band. Proper handling of the dumbbell is ensured by including gripping techniques. Use of protective equipment such as gloves or weight belts is encouraged. Rest periods and proper body mechanics are used, with a gradual return to sport within three months.

Anterior Capsule Elbow Strain

Capsular elbow strain refers to a global injury to the elbow capsule, usually anteriorly, and is an entity different from the classic medial or lateral collateral ligament injuries. It often occurs in conjunction with inflammation of the brachialis muscle. Predisposing factors are present in patients with ligamentous laxity where hyperextension of the elbow is already present and is exacerbated by the athletic activity in particular, such as gymnastics. Certain sports activities predispose the elbow to this particular problem, and Tyrdal and Sanderhoff noted that this lesion may be responsible for pain in “handball goalie’s elbow.” In fact, nearly 75% of these goalkeepers had elbow problems during their careers that were sustained through hyperextension trauma when attempting to block a shot.

Conservative Management

Conservative management includes pain-relieving modalities such as ultrasound and friction massage to the affected region of the anterior capsule of the elbow along with a short period of immobilization with the elbow in 90° flexion and forearm in neutral for approximately two to three weeks. Because there is usually painful swelling in the antecubital area, ice is the modality of choice, followed by gentle stretching, ROM, and strengthening of the surrounding musculature.

Endurance activities such as the use of the upper extremity ergometer should also be incorporated along with specific exercises to strengthen the brachialis muscle (Figure 7). The brachialis muscle acts

FIGURE 7. Use of the upper extremity ergometer to perform warm-up and endurance activities.
as a stabilizer to the elbow and can be strengthened by performing both hammer and reserve curls (Figures 8A and 8B). The brachialis muscle helps to stabilize the elbow during the pause phase that is required during competition bench press and is an important part of the weight lifter’s program.

The need for surgical intervention in this population is rare.

Cubital Tunnel Syndrome

Anatomic findings that can predispose an athlete to cubital tunnel syndrome can include hypertrophy of the medial head of the triceps as well as the origin of the pronator flexor muscles, as may be seen in weight-lifting athletes. Dynamic mechanisms are once again seen in the overhead thrower where the extreme valgus stress can cause a traction neuropathy due to laxity of the medial collateral complex or a true compressive neuropathy when osteophytes within the cubital tunnel can cause direct nerve impingement.

Conservative Management

Volar splinting of the elbow in 30–40° flexion during sleep is recommended for six to eight weeks. Since increased flexion puts tension on the nerve, full flexion of the elbow should be avoided. During the day, an elbow pad is used with activities. The athlete is instructed on avoidance of repetitive elbow flexion and extension of the elbow. Rest from the aggravating activity followed by a gradual return to the sporting activity is stressed. Cessation of exacerbating exercises such as triceps extension exercises and those that involve prolonged elbow flexion is important in the recovery process. Appropriate warm-ups should be performed before the start of each exercise such as elbow, forearm, and wrist flexibility stretches along with proper cardiovascular exercises. Modalities may have a role in healing. Progressive strengthening exercises starting with isometrics at approximately six weeks are added as needed and if this does not exacerbate symptoms, if the symptoms return with activities, then further intervention is needed.

Operative Treatment

There are a variety of choices for relieving compression of the ulnar nerve at the elbow. Traditionally, anterior transposition of the ulnar nerve has been done with a subcutaneous technique and is further discussed in a paper in this issue by Lund and Amadio. Earlier papers have described the classic Learmonth technique where the ulnar nerve is placed completely underneath the detached flexor–pronator mass. Obviously, this can cause problems for the athlete and a prolonged recovery is needed in order to regain grip strength and ROM. However, it provides better protection for the nerve so that it is not exposed subcutaneously to direct trauma and provides minimal cushion around the nerve since most athletes tend to have a low percentage of body fat.

For this reason, one of the authors (AB) prefers an intramuscular transposition that allows the benefit of greater nerve protection while minimizing trauma to the flexor–pronator mass origin. The key to this procedure is to perform lengthening of the fascia in order to avoid constriction of the nerve and minimize tension during the rehabilitation. Our current surgical protocol at the Miami Hand Center consists of an intramuscular anterior transposition of the nerve through a minimal incision, avoiding scarring about the nerve extrinsically. Therapy begins one week after the surgery, with the intent of facilitating a more rapid recovery.

Postoperative Rehabilitation Program

During the first week after surgery, immobilization of the elbow is done with a bulky dressing, with posterior splint in 60° flexion and forearm in neutral,
to keep tension off the nerve. An ace wrap is used for edema control and to protect the surgical site. Active ROM for the entire upper extremity is initiated along with elevation and gripping activities. Gentle active ROM to the elbow is used with the forearm pronated and wrist flexed slightly to take the tension of the repair. Exercises are performed for 20–30 repetitions three to four times per day. Scar massage is performed with lotions or creams, and desensitization of the scar site is also addressed if needed as scars can cause discomfort at the site if they are restricted. Silicone gel sheeting or elastomer molds are used over the scar site to decrease adherence and improve appearance. Shoulder, wrist, and digit isometrics are performed during this initial three weeks to maintain proximal and distal strength.

At approximately three weeks postoperatively, the focus on elbow extension ROM is emphasized. An elbow pad is placed for comfort and protection during activity. At about six weeks, moist heat along with stretch may be used to assist with extension as achieving full elbow extension with forearm supination seems to be most difficult. Strength athletes such as bodybuilders, weight lifters, and power lifters begin resistive training after six weeks with focus on using elbow flexors and extensors, and progress from isometric, eccentric, and concentric contractions to isokinetic exercises. At eight weeks, light sport activities are instituted, with a guided throwing program initiated with light tossing activities and with return to sport at 12 weeks, with all restrictions generally lifted.

Other Compression Neuropathies

Other compression neuropathies that are uncommonly seen include radial tunnel syndrome, as well as pronator teres syndrome involving the median nerve. It is important not to confuse radial tunnel syndrome with lateral epicondylitis, as the hallmark of the former condition is tenderness along the course of the radial nerve much more distal than is usually seen in lateral epicondylitis. Unfortunately, nerve conduction studies have been notoriously poor in detecting this neuropathy, and one must often make the diagnosis by clinical means.

Operative Treatment and Postoperative Rehabilitation Program

If a patient has significant tenderness with resisted extension of the middle finger or tenderness along the course of the supinator, a simple in situ release of the radial nerve should be done at the same time as a release of the fascia of the extensor wrad. This requires an incision more distal than the usual approach for lateral epicondylitis, and requires only a brief rehabilitation after surgery.

Postoperative therapy includes initiation of gentle active ROM progressing to active assisted ROM and passive ROM. Pain-relieving modalities are used to decrease pain and muscle spasms along with massage techniques to increase circulation. Scar massage is used to desensitize the site. Nerve gliding exercises are initiated as the ROM improves. The nerve gliding exercises should be performed under the direct supervision of the therapist to minimize nerve irritability.

The focus is on gaining full ROM over the initial three weeks followed by gentle resistive exercises starting with therapeutic and hand gripper resistive exercises. At approximately six weeks, the athlete will begin strengthening for the wrist, elbow, and forearm musculature. Isometrics are tolerated initially and progressed to eccentric and concentrics. Plyometrics such as ball tossing activities engaging the entire upper extremity are used.

Initiation into sporting activities is accomplished once the ROM and strength have returned. For example in baseball, the throwing activity commences with tossing a ball for shorter distances and fewer repetitions. The activity is graded by increasing the distance and the number of repetitions as well as adding more effort with each throw. Throwing power and speed are increased over the next few months. Before performing the sport activity, a heating pad is often effective to assist with warming the musculature; a cold pack after training is effective to assist with any inflammation that may occur.

Pronator Teres

Pronator teres syndrome can be seen at a greater rate in athletes compared with nonathletes due to the extreme hypertrophy of the proximal forearm musculature seen in certain individuals. Direct external compression can occur in sports where a great deal of tension is applied directly to the forearm.
musculature as required in certain gymnastics maneuvers. One of the authors (AB) has seen this in a Cirque du Soleil acrobat who had a curtain of material tightly wrapped around the proximal forearm area in order to perform an acrobatic routine. This chronic external compression apparently led to his symptoms. This compression can also be seen in pitchers as well as rowers.

**Conservative Management**

Conservative management includes rest from repetitive, forceful gripping and pronation motions along with rapid eccentric and concentric flexion of the forearm. Activity modification such as modifying equipment or changing positions and body mechanics is sometimes helpful. In our experience, conservative management of pronator syndrome is often unsuccessful with this population; thus, surgical management is often the preferred intervention.

**Operative Management**

Regardless of the etiology, it is important to release the median nerve at all common sites of compression proximally in order to avoid missing any key point of compression. This includes the ligament of Struthers, the lacertus fibrosis, as well as both heads of the pronator teres and the flexor digitorum superficialis origin.

**Postoperative Rehabilitation Program**

Following the surgical release, the athlete’s elbow is placed in a posterior splint in approximately 60–70° elbow flexion and the forearm pronated 30–40°. Gentle active ROM exercises are initiated immediately, followed by light resistive exercises initiated at about three to four weeks with isometrics and proximal and distal muscle strengthening. The focus is on strengthening of the forearm flexor group. Scar management is emphasized when necessary. At approximately six to eight weeks, sports-specific exercises are initiated as tolerated. Modifications are made with activities as necessary to prevent further re-injury. Motorcyclists who perform distance racing may develop this chronic syndrome due to the continuous flexor contraction that is necessitated to control the brake lever and keep the bike on the road. Adjustments should be made with the cyclists regarding repositioning the hand frequently to relieve the pressure from the forearm musculature, take frequent breaks when, and ensure proper warm-up with stretching prior to the activity.

**Elbow Instability**

The presence and extent of elbow instability in the athlete can be a difficult diagnosis to determine. Subtle instabilities can be a source of elbow pain and yet not be clear on physical examination. Arthroscopy has provided the benefit of assessing articular changes that can be related to these instabilities and allows us to assess the capsule and ligaments directly. Nevertheless, the majority of instabilities are based upon a history such as medial elbow pain that occurs in the acceleration phase of the throwing motion. Less common lateral instabilities are often confused with more common conditions such as lateral epicondylitis. Provocative physical exam maneuvers are necessary in order to assist with the diagnosis, but it is important to confirm these with imaging studies with a diagnostic arthroscopy in many cases (Figure 10).

**Chronic Ulnar Collateral Injuries**

Medial instability may be treated with the rest of the instabilities and the appropriate rehabilitation of immobilization in elbow flexion, followed by active mobilization, pain-relieving modalities, and activity modification. Ulnar collateral ligament injuries are associated with repetitive valgus extension overload on the elbow joint. The athlete usually complains of pain on the medial side primarily with throwing, and the pain increases after several innings, causing a decrease in strength ability. It is also common in racquet sports, arm wrestlers, and javelin throwers. Severe cases often require surgical intervention.

**FIGURE 10.** Posterior elbow illustrating surface landmarks and portal placement for elbow arthroscopic release of lateral epicondylitis.
Postoperative Rehabilitation Program

After surgical repair of the UCL, the elbow is immobilized at 90° flexion, with the forearm in neutral in a posterior splint and the wrist free. Edema is managed through the use of compression wraps. In addition, cold packs are used for 10- to 15-minute increments four to five times per day. Scar mobilization techniques are used as needed to address any restrictions noted. An elbow hinged splint is then used to allow ROM increases at the end of each week. The splint is initially locked at 90° flexion for the first week to allow tissue healing. At the end of the second week, the motion allowed is 30–100° flexion. At the end of the third week, the motion allowed is 15–110°. At the end of six weeks, the athlete should have 0–145°. Submaximal isometrics are initiated for the forearm and wrist to prevent muscle atrophy. Isometric exercises for the shoulder are performed in all planes. A detailed strengthening program is imperative before initiating sport activities since the FDS and FCU musculature must be strengthened to decrease the stress on the UCL during the overhead activities. The primary goal at this time is to gradually restore full ROM at approximately four to six weeks, then advance to restore power and endurance. During week 6, dumbbells or light weights can be used for strengthening the elbow flexors and extensors to assist with concentric and eccentric strengthening. Scarring is also addressed during this time period as it is important to avoid a flexion contracture. Low-load stretching is used to address limitations in ROM. At approximately nine to 14 weeks, the athlete’s program will consist mainly of plyometric exercises and intensive eccentric strengthening exercises. Plyometrics using a plyoball for throws are initiated with light resistive balls for throwing positions (Figure 11). For the thrower, strengthening the biceps muscle is the key stabilizer in the follow-through phase of throwing.

For throwers, the throwing programs are usually initiated at about four months with return to competitive pitching in about nine to 12 months after intensive rehabilitation. In order to return to pitching, the athlete must demonstrate nonpainful ROM and a good clinical exam. A throwing program that starts with light tossing is usually initiated at about three to four months. As the strength and endurance of the athlete improves, the distance of the throw and the speed of the throw are increased. At about six months, the athlete begins lobbing the ball using an easy windup for a distance of approximately 60 ft. At seven months, the velocity of the throw is advanced by approximately 50%, and at eight to nine months, pitchers return to the mound and throw with 70% of maximum velocity. All mechanics of pitching are addressed throughout this period, focusing on the total athlete body performance. At approximately 12 months following surgical intervention, the athlete is usually able to perform at his or her pre-injury level (Figure 11). (See Table 3 for a sample throwing program suggested for use with this population.)

While posterolateral instability is relatively uncommon, it specifically may require surgical reconstruction of the lateral ulnar collateral ligament and may require a prolonged period of recovery. This particular instability usually comes from a previously unrecognized traumatic episode that has led to incompetence of the lateral structures.

Elbow Contractures

Flexion contractures of the elbow are very often iatrogenic and related to previous surgery where rehabilitation has not sufficed. Certain patients tend to form a dense capsular scar leading to contracture. Most notably, the loss of full extension is common after elbow reconstruction and may need to be addressed as a separate procedure if the response to therapy is inadequate. Although an elbow ROM of 30–130° is considered functional for most activities, this is not adequate for most athletes. Loss of elbow flexion is more functionally limiting for ADL activities, but for the athlete involved in sports such as gymnastics and for overhead throwers, full extension is vital to athletic performance.

Conservative Management

Conservative treatments include stretching exercises for the restricted tissues, joint and soft tissue mobilizations, ROM exercises, strengthening exercises, and pain management techniques. If conservative efforts such as static progressive, dynamic, and serial static splinting fail to improve the athlete’s motion, surgical intervention may be warranted.

![FIGURE 11. Plyometrics using a plyoball to perform overhead and forward throws.](image)
Throwing sports such as baseball, football, tennis, and javelin place excessive stress on the elbow and can cause significant injury to the joint and the soft tissues surrounding the elbow.

This is a guideline to assist throwing athletes to return to their sport as quickly and safely as possible.

**Phase 1**

The primary goal in this phase is to gain full elbow extension.

ROM: early motion of active assisted and passive ROM is imperative to avoid flexor contractures.

Joint mobilizations to humero-ulnar and humeroradial joints to assist with elbow extension are performed.

Passive elbow extension stretch with weight for 5-7 minutes for a low-load prolonged stretch.

Modalities to decrease pain such as ultrasound, cold packs, TENS, and heat pads.

Submaximal isometrics to avoid muscle atrophy for the elbow, wrist, and forearm performed in multiple angles for three sets of ten repetitions.

**Phase 2**

In order to progress to this phase, the athlete should have full ROM, minimal pain, and good manual muscle test of the elbow.

Focus on stretches to gain elbow extension and forearm pronation, which are critical motions for the athlete to regain.

Strengthening exercises are continued and progress with isotonics with dumbbells for the triceps, biceps, forearm, and wrist.

Resistance is increased without pain, ensuring that proper technique and body mechanics are used.

Exercises are performed initially without weight for two sets of ten and then increased to five sets of ten. Once the athlete can perform this without pain, a dumbbell weight is added, and the sets are decreased to two with ten repetitions of each and then increased as tolerated without pain. Resistance is increased along with repetitions to increase both strength and endurance. Shoulder strengthening is also performed at this time focusing on the rotator cuff.

Neuromuscular control activities to assist the athlete in control of the elbow throughout his sport are emphasized.

**Phase 3**

The primary goal of this phase is to prepare the athlete for gradual return to throwing by increasing power, endurance, and participation in functional activities without any restrictions. The athlete must demonstrate pain-free full ROM to enter this phase.

Advanced strengthening exercises including eccentric muscular contraction, plyometrics, and high-speed and high-energy exercises are performed relative to the sport.

Biceps muscle—important stabilizer during the follow-through phase of throwing as they eccentrically contract to prevent elbow hyperextension. Strengthening using elastic theraband along with plyometrics is very effective.

Triceps muscle—important during the acceleration phase of throwing and is also strengthened using elastic theraband to emphasize muscular contractions.

Forearm flexor–pronator group is important in its medial stabilization of the forearm during throwing and must also be strengthened by wrist flexion and forearm pronation exercises with theraband.

Rotator cuff—to strengthen the rotator cuff, the “Throwers Ten Program” is used. These exercises provide submaximal isotonic muscular contractions for the shoulder complex and enhance shoulder stability.

Plyometrics assist the athlete to engage the total body while transferring energy, stabilizing the affected elbow and allowing the specifics of the acceleration and deceleration of the throwing arm. Weighted balls are used, and the athlete throws the ball against a screen and the ball bounces back, the athlete catches the ball and throws it back immediately. The activities are performed rapidly to assist with explosive power and control.

**Phase 4**

The goal of this phase is to return the athlete to his sport by ensuring that motion, strength, and function are achieved prior to return to competition level.

An interval-throwing program is initiated. The throwing athlete should begin throwing from about 30 to 45 ft and should gradually increase the distance to 180 ft, performing up to 75 throws at each distance. When the athlete progresses to throwing at 180 ft, he or she then initiates throwing off the mound. Throwing off the mound is started at 50% of the effort and speed as required. The importance of the proper mechanics of the throw is stressed to the athlete, and a pitching coach is used to ensure that mechanics are performed correctly. If the athlete has any increased pain or difficulty with any of the activities throughout the interval program, the throwing program is modified as needed. The program continues with simulation of the actual game conditions to prepare the athlete for return to the sport.

ROM = range of motion; TENS = transcutaneous electrical nerve stimulation.

**Operative Treatment**

Because of the extensive dissection that can be caused by an open surgical capsulotomy of the elbow, it is preferable to attempt an arthroscopic release as long as the flexion contracture is not severe.

This must be combined with a postoperative splinting regimen, as well as the appropriate rehabilitation, to allow for a more rapid return to athletic activity.

Open capsular releases should be done in a limited manner that avoids disruption of intact collateral ligament since this can cause subtle instabilities of the elbow that are problems for the athlete as discussed.

Modified approaches such as those described by Kraushaar et al. allow for preservation of the common extensor origin and collateral ligament while allowing for good visualization of the anterior elbow, which is the usual site of capsular contracture. A separate incision can be done posteriorly with a triceps splitting method to have access to excise any impinging osteophytes or remove the capsule posteriorly.
not disrupt the normal stabilizers of the elbow, and thus can allow for eventual return to normal athletic activity.

Postoperative Rehabilitation Program

Following surgical release of the joint capsule and periarticular structures, intensive therapy must be quickly initiated to prevent recurrence of contracture. The rehabilitation goal of surgery is to obtain nearly full ROM quickly while avoiding further inflammation. A continuous passive motion (CPM) machine is helpful to prevent stiffness and minimize the edema and pain. The CPM is often applied on the patient in the recovery room immediately after surgery. The CPM takes the elbow through the full ROM attained in surgery for use in a one-hour increment five to six hours per day for approximately three to four weeks. The CPM is adjusted to the ROM tolerated by the patient, and it should give the patient a stretch for 10–20 seconds. The CPM is discontinued once the athlete is able to consistently maintain the achieved ROM.

Splinting techniques, such as dynamic and static progressive splinting, work under the principle of prolonged stress to remodel tissue in lengthened position and are used in patients having difficulty gaining the end ROM. Two examples of commonly used dynamic splints are Dynasplint (Dynasplints Systems Inc., Severna Park, MD) and DeRoyal LMB (DeRoyal LMB Industries, Powell, TN) (Figures 12–14).

Load stretching maneuvers, along with proprioceptive neuromuscular facilitation patterns, are quite effective for restoring passive ROM. A combination of a heat modality with stretch will elongate the tissue and prepare it for exercise by increasing blood flow and altering the viscoelastic properties of the tissue. Active and active assisted and passive ROM exercises are initiated to the elbow for flexion and extension and to the forearm supination and pronation. Exercises are performed for 30 repetitions each hour. ROM exercises are also performed for the non-involved joints. Modalities such as transcutaneous electrical nerve stimulation (TENS) are used to assist in management of pain and can be used as early as three days post-op.

At approximately two weeks postoperative, neuromuscular electrical stimulation can be used to increase the contraction of the triceps/biceps muscles. Progressive resistive exercises are initiated once pain decreases, beginning with isometric exercise, for the flexors and extensors, progressing to isotonic exercise and then to isokinetic exercise when functional ROM improves. Strengthening exercises assist the elbow work through its limitations. Prolonged splinting, primarily a night static splint, is used and is decreased over the next several months is often required to prevent further contractures from recurring.

Elbow Arthritis

Arthritic findings in the elbow are often attributed to changes resulting in articular cartilage damage from chronic instability. This is, once again, most implicated in the elbow of throwing athletes. Pain from this instability will usually lead to treatment before arthritis becomes a major problem. Arthritic symptoms can be very disabling to the athlete and are commonly caused by an overuse or a repetitive trauma.
A detailed evaluation of the athlete is important in determining the history of the pain and the specific activity with which the pain is associated.

Conservative Management

Conservative management includes anti-inflammatory medications, rest from the aggravating activity, and pain-relieving modalities as needed. It also includes progressive exercises such as pain-free active ROM and active assisted ROM for all joints, resistive and endurance activities when tolerated, and gradual return to sport once the pain has subsided.50

Operative Treatment

Most of these changes are seen in the lateral compartment due to the valgus mechanism of injury as well as in the posterior compartment when the olecranon impinges upon the medial aspect of the olecranon fossa. This can lead to loose bodies that are commonly referred to as “bone chips” by the lay press when discussing the need for arthroscopic debridement and excision of osteochondral fragments in an athlete’s elbow.51 Obviously, these debridements and loose body excisions will only be a temporizing measure if the underlying problem of instability is not adequately addressed.

Radiofrequency probes during arthroscopy can be used to manage capsular fraying and redundancy that can occur with these entities and also allow for the treatment of articular cartilage focal defects.52 Although the short-term results using this approach are good to excellent, the long-term results of these thermal procedures are as of yet unknown.

Postoperative Rehabilitation Program

After the surgical debridement is performed, focus is on pain-free ROM, edema control, gradual strengthening, and return to activities. Modalities such as moist heat and ultrasound can be applied prior to stretch to assist motion. Active and passive ROMs are performed for all planes of the elbow and focus on decreasing adhesions. The goal is to gain full elbow extension as soon as possible to prevent flexor contractures. Joint mobilizations to the humeroradial and humero-ulnar joints are effective in gaining elbow extension.15 Passive elbow extension stretches are also very effective for 10- to 15-minute increments.

Once ROM is gained, strengthening and endurance exercises are the key. Dumbbell weights for isotonic contractions should be used for the elbow and forearm. Strengthening of the shoulder occurs at this time. For example, with the gymnasts, return to sport is often accomplished quite quickly as the joint stability has not been compromised when arthroscopic procedures are performed. Unfortunately, the external stresses on the athlete to perform often lead us to use temporizing measures that will allow him or her to continue playing but may lead to continued problems in his or her elbow in the future. Procedures to address instability may obviously preclude continued competition.

ACUTE INJURY AND MANAGEMENT

Ligament Injuries

Ulnar collateral ligament injuries of the elbow have already been mentioned as a type of chronic lesion. However, in rare cases, a complete ligamentous injury can be seen in the form of a midsubstance tear or a complete avulsion with or without a bony attachment.

Operative Treatment

This type of acute lesion obviously requires operative treatment; there is little place for conservative
Fractures about the Elbow

Higher energy trauma seen in sports can occasionally cause fractures about the elbow. These can be either from a direct impact or from an avulsion-type mechanism where the ligamentous or tendinous attachment can cause a fracture near its insertion point. Radial head fractures continue to be the most common fracture about the elbow for both the non-athlete and the athlete. These are usually of an indirect nature where the athlete falls on the outstretched arm, and the consequent valgus stress causes fracture to the articular surface or the radial neck. Most of these fractures tend to be minimally displaced due to the good bone quality usually seen in the athlete and Mason Type I fractures typically result.

Conservative Management

Conservative management of these fractures includes immobilization for one week in a sling to protect the radial head followed by graded active and active assistive ROM exercises four to five times daily. Sling use is minimized, and a sling is used when in public areas or at night for sleeping for the following two to three weeks. Gentle passive ROM can commence at approximately two to three weeks in order to lengthen and remodel the tissue. By five to six weeks, joint mobilizations of gentle grade one and two oscillations, to minimize pain of muscle spams, coupled with gentle resistive exercises are begun. Herbertsson et al. indicated that the long-term results of nonoperatively treated Type I fractures were favorable with no long-term sequelae.

Operative Treatment

Ligament injuries can often be much more disabling fractures. However, more severe fractures of the radial head or neck will require not only fracture stabilization or even radial head replacement but, again, need to have attention addressed to the ligamentous injury. This type of mechanism can lead to a different fracture pattern in the skeletally immature athlete.

Postoperative Rehabilitation Program

After open reduction internal fixation, radial head excision, or prosthetic replacement, such as with an Essex-Lopressti lesion, the patient must begin early active motion within the first few days. The active motion promotes bone healing, increases tensile strength, and minimizes the adhesions that cause joint stiffness.

At the first postoperative visit, a splint with the elbow at 90° and the forearm in neutral is fabricated, which is discontinued at approximately six weeks. The splint is removed for therapy and for ROM exercises four to five times per day. Gentle ROM exercises are instituted with active ROM to the elbow, wrist, and forearm along with the use of pain-relieving modalities to address post-op discomfort. TENS is often used to assist with the pain levels. The focus of supervised exercise is often on recovering full elbow extension. At approximately two weeks, active assisted and passive ROMs to the forearm and elbow are performed to the athlete’s tolerance. Static
progressive or dynamic splinting may be a required adjunct to treatment for patients having difficulty with gaining end ROM. Progressive strengthening exercises are often started for the entire upper extremity after the splint removal. The athlete will start with hand gripper, pinch strengthening, and putty exercises, initially with isometrics for the elbow and forearm as the pain levels improve. Gradual return to play and sport begins within three to four months.

Complex Fractures

Due to the increasing popularity of so-called “extreme sports,” there is an increasing incidence of more complex fractures about the elbow. It is important that the surgeon managing these athletes is well versed in standard principles of fracture fixation. High-energy activities, such as mountain biking or trick skateboarding, can often lead to devastating fractures, particularly supracondylar or intercondylar distal humerus fractures (Figures 15–17).

Operative Treatment

Medial and posterolateral plating remains the gold standard for these adult fractures involving the distal humerus. Management may even require an olecranon osteotomy to achieve adequate articular reduction. The surgical fixation should allow early motion to be initiated, particularly in the athlete. If there is prolonged immobilization with these fractures, a flexion contracture or global elbow stiffness is likely to ensue.

Postoperative Rehabilitation Program

This stable fixation is followed by the ability to initiate early motion. A protective splint is fabricated four to five days postoperatively, and active ROM is initiated at that time. To minimize effects of gravity, the exercises are performed primarily in supine to assist flexion and sitting for extension. The goal is to initiate active and active assisted ROM of the elbow, wrist, and hand to avoid scar adhesions from forming. It is important to gain elbow extension. Supine activities are used to facilitate massage for edema more effectively. Edema control is managed with light compressive garments. Pain-relieving modalities such as moist heat and icing assist the athletes as they progress. ROM of the noninvolved joints is also performed. A CPM is used within a safe arc of motion and is often applied immediately after surgery to assist through the inflammatory phase of healing. Stretching exercises are initiated to address the elbow ROM limitations.

Strengthening exercises are usually initiated at around eight to 12 weeks and progressed as tolerated. Strength is addressed with isometrics and dumbbell isotonic exercises. This is followed with an increasing program to strengthening focusing on the sport with plyometric activities. For example with the baseball pitcher, the athlete places an isometric hold with the tubing into flexion and then releases the hold and allows the elbow to extend rapidly. Once the elbow extension is achieved, the motion is quickly returned back to flexion. Specific modalities and further splinting are instituted as needed, in addition to sports-specific rehabilitation (Figures 12–14).

**FIGURE 15.** Preoperative x-rays of ipsilateral intercondylar distal humerus fracture and Galleazzi lesion in a young cyclist.

**FIGURE 16.** Intraoperative view of fixation for intercondylar distal humerus fracture via olecranon osteotomy exposure.
Medial Epicondyle Fractures

Medial epicondyle fractures are notoriously common in the child and early adolescent. A study by Lee et al. indicated that operative treatment is preferable for managing these fractures in children. The results did not correlate with the injury mechanism or the type of fixation used. The more occult, nondisplaced fractures need to be addressed as well but can usually be done with conservative means. This type of injury falls into the spectrum of “little leaguer’s elbow.” These can often respond simply to rest and temporary cessation of the aggravating activity. Stretching exercises for the elbow along with progressive strengthening exercises follow. Throwing activities are usually initiated at about six weeks. It is important that the trainer and coach both understand the limits of the child’s elbow, particularly in regard to overhead-throwing sports.

Pediatric Fractures

Fractures in children remain a different entity compared with the adult, and many of these can be managed simply with K-wire fixation if the displacement warrants this. Severely displaced supracondylar fractures can lead to neurovascular compromise and a careful pre-op exam is necessary, with close monitoring in the early post-operative period. Isolated capitellum fractures are occasionally seen, and these usually require screw fixation with careful attention to the articular reduction.

With many articular elbow fractures, arthroscopic techniques can now be used to obtain a better reduction and improve an athlete’s chance of return to a sport. Less obvious injuries to the articular surface include OCD, where the bony fragment separates from the subchondral region. Many of these cases have been found in baseball players and gymnasts due to the loading on the lateral side of the elbow.

This is often treated conservatively if there are no loose bodies present with a short course of rehabilitation. The gymnast is treated with a period of rest, icing, and focus on bicep strengthening exercises in order to decrease the elbow hyperextension that occurs. Although traumatic mechanisms are implicated, there can also be vascular causes for this and it is important to determine if this is a stable or an unstable lesion. The juvenile form has a better prognosis and may heal with nonoperative treatment. If instability is suspected, a wide variety of internal fixation devices can be used for these lesions in the adult. Internal fixation of any of these fractures about the elbow must be rigid and allow for early motion, particularly in the high-demand athlete. This is because elbow contracture is commonly seen, as previously discussed, and one can avoid capsular contracture by instituting early motion and rehabilitation. This requires stable fragment fixation. The younger patient requires only a short period of immobilization, followed by initiation of early protected ROM, followed by resistive exercises when there is no longer pain or tenderness in the elbow. Return to throwing is initiated when the ROM and the strength are more than 90% of the contralateral side.

Musculotendinous Avulsions

Musculotendinous avulsions are much less common than one would think based on the mechanism of sports injuries. There has been an increasing incidence of distal bicep tendon ruptures in recent decades, but this trend is likely the result of increased activity in the middle-aged population. Younger athletes rarely have this injury probably due to the strong insertion of Sharpey’s fibers upon the periosteum and cortical bone junction. The incidence of this lesion is overwhelmingly present in men, but...
again, they tend to be middle aged and very often are laborers. On occasion, weight-lifting athletes will suffer a bicep tendon avulsion, but there may be some relationship to anabolic steroid usage and the effects of this drug on tendon tensile strength.

Operative Treatment. Operative repair remains the mainstay of treatment, particularly in active adults and that would certainly include the competitive athlete (Figure 18). Traditionally, two-incision techniques have been the norm, but recent changes in internal fixation techniques have led to more interest in a single anterior incision. Mazzocca et al. described a single-incision technique using an interference screw for the repair of the distal bicep. Soteranos et al. described the use of two simple bone anchors to achieve a similar goal. Nevertheless, one is depending on the integrity of these fixation systems, and it is our feeling that the high-demand athlete benefits from a two-incision technique where the heavy suture is tied directly to the bone and, hence, relies on the integrity of bone strength. This is a similar concept in that bone tunnels are often preferred in the use of massive rotator cuff tears in athletes where a strong and reliable repair is necessary. However, biomechanical studies have demonstrated that these single-portal techniques are equivalent and clinical experience over the long term will determine the preferred technique.

Postoperative Rehabilitation Program. After the surgical reattachment of the bicep tendon, the patient is placed in a posterior elbow splint at 90° with the forearm in full supination (Figure 19). Gentle passive ROM into elbow flexion is initiated with no extension past 90°. A hinged brace is used to prevent motion past 90°. The triceps musculature is maintained with isometric exercises. The brace is increased slowly into extension and removed at approximately six weeks. At approximately six weeks, active and passive elbow flexion and continued elbow extension exercises are initiated. Strengthening exercises are initiated with isometrics for the biceps, triceps, and forearm muscles progressing to concentric and eccentric exercises. More aggressive strengthening exercises are usually initiated at about three months.

Triceps Tendon Avulsions

Triceps tendon avulsions are extremely uncommon and are most closely associated with power-lifting activity. Similarly, acute tears would require repair and a period of immobilization with a splint for approximately three weeks to allow for tendon-to-bone healing. Exercises would then include active flexion and passive extension exercises, with active extension exercises being initiated at six weeks. Progressive strengthening exercises are initiated at around eight weeks. There is gradual return to sport after strength has been achieved with focus on specifics for the sport. For the power lifter, focus on proper techniques, handling of the equipment, body mechanics, and progressive weight lifts is important in safely returning the athlete to his prior level.

CONCLUSION

Sports injuries about the elbow are relatively common entities that are seen by a wide variety of clinicians. It is important that the specialist managing...
these pathologies have a good understanding of the biomechanics of the elbow and common patterns of injury. Fortunately, most injuries can be overcome with the correct combination of surgical or conservative treatment and rehabilitation. A thorough understanding of soft tissue injuries, bony trauma, and compression neuropathies is necessary to address the varying patterns of injury seen in the athlete’s elbow.

UNCITED REFERENCE

59.

REFERENCES

Record your answers on the Return Answer Form found on the tear-out coupon at the back of this issue. There is only one best answer for each question.

#1. Elbow injuries in athletes most commonly are seen:
   a. following direct trauma
   b. in football players
   c. more frequently in women than in men
   d. in throwing athletes

#2. The following ligament is the most important stabilizer preventing posterolateral rotatory instability:
   a. anterior bundle of the medial collateral
   b. the posterior bundle of the medial collateral
   c. lateral ulnar collateral
   d. anterior joint capsule

#3. "Tommy John surgery" is:
   a. ulnar collateral ligament reconstruction
   b. lateral collateral ligament reconstruction
   c. designed to correct varus instability
   d. an adaptation of the classic rotator cuff repair described by Jobe

#4. The most frequent cause of elbow pain in athletes is:
   a. cubital tunnel syndrome
   b. epicondylitis
   c. instability
   d. tight anterior joint capsule

#5. Unlike the nonathletic population, often the athlete requires:
   a. full elbow flexion for good function
   b. full elbow extension for good function
   c. excessive valgus freedom for full function
   d. excessive varus freedom for full function

When submitting to the HTCC for recertification, please batch your JHT RFC certificates in groups of three or more to get full credit.