Elbow Arthroscopy

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Abstract

Arthroscopy of the elbow was originally considered to be an unsafe procedure because of the small size of the elbow joint capsule and its proximity to several crucial neurovascular structures. Over the past decade, however, the procedure has become safer and more effective. These improvements can be attributed to a better understanding of elbow anatomy and of the disorders about the elbow as well as to advances in arthroscopic equipment and surgical technique. The most common indications for elbow arthroscopy include removal of loose bodies, synovectomy, débridement and/or excision of osteophytes, capsular release, and the assessment and treatment of osteochondritis dissecans. More recent advances have expanded the indications of elbow arthroscopy to include fracture management (eg, radial head fractures) and the treatment of lateral epicondylitis.

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Although the first reports of elbow arthroscopy appeared in 1931, the modern technique was introduced more than 50 years later. In 1985, Andrews and Carson[1] described visualization of elbow intra-articular anatomy via anterolateral, anteromedial, and posterolateral portals with the patient in a supine position. Improved instrumentation and more precise surgical techniques have made elbow arthroscopy a more common procedure and one that is now a safe and effective treatment modality for several elbow pathologies.

Patient History

A comprehensive patient history is crucial to developing a differential diagnosis. The examiner should try to determine whether the signs and symptoms are the result of an acute traumatic event or repetitive traumatic episodes. In addition, patient age, dominant extremity, activity level, comorbidities, occupation, and history of trauma are important to ascertain.

The examiner should determine the location of reported pain. Dividing the elbow into four anatomic regions (ie, lateral, medial, anterior, posterior) helps to narrow the differential diagnosis. For example, symptoms in the lateral region of the elbow may be indicative of radiocapitellar chondromalacia, osteochondral loose bodies, radial head fracture, and osteochondritis dissecans (OCD) lesions. Symptoms in the medial region can indicate ulnar collateral ligament (UCL) sprain or rupture, a medial epicondyle avulsion fracture, ulnar neuritis, ulnar nerve subluxation, or medial epicondylitis. The differential diagnosis for symptoms of the anterior elbow includes distal biceps rupture, anterior capsular strain, and brachialis muscle strain. Symptoms in the posterior compartment can reflect valgus extension overload syndrome, posterior impingement, osteochondral loose bodies, triceps tendinitis, triceps tendon avulsion, olecranon stress fracture, and olecranon bursitis.[2]

The examiner should ask the patient about the presence and character of pain, swelling, and locking or catching episodes. Sharp pain radiating down the medial portion of the forearm with paresthesias in the fifth digit and in the ulnar-innervated half of the fourth digit can indicate ulnar neuritis or cubital tunnel syndrome. When these symptoms are associated with a snapping or popping sensation, ulnar nerve subluxation may be the cause. Deep, aching pain localized to the posterior region of the elbow may be indicative of an olecranon stress fracture.[2,3] Sharp pain in the lateral region that is associated with locking or catching can be the result of loose bodies in the radiocapitellar joint caused by an OCD lesion of the capitellum.[4,5] Chronic pain over the lateral epicondyle of the elbow can be caused by lateral epicondylitis. Acute, sharp pain in the anterior region of the elbow may be caused by an acute distal biceps rupture, whereas persistent chronic anterior elbow pain may reflect inflammation of the anterior capsule.

Throwing athletes are a unique patient population, and in examining them, it is important to gather information about prior injury and any changes in the throwing mechanism or rehabilitation regimen. For the throwing athlete, the phase of throwing and any change in accuracy, velocity, stamina, or strength can help provide information about the specific diagnosis. Pain during the late cocking phase caused by excessive valgus stresses on the medial region of the elbow can indicate UCL insufficiency or ulnar neuritis. Young throwing athletes (<18 years) with OCD lesions often report progressive lateral elbow pain during the late acceleration and follow-through phases, with loss of extension and episodes of locking.[4,5] Posteromedial pain that is worse during the late cocking and early acceleration phases of throwing may be indicative of valgus extension overload syndrome.[6]

Physical Examination

The physical examination of the elbow begins with the cervical spine and includes the ipsilateral shoulder and the contralateral elbow, followed by examination of the involved elbow. Neurovascular assessment of the involved extremity, including motor and sensory testing and reflexes, is equally important.

Inspection

The lateral, posterior, medial, and anterior regions of the involved elbow should be examined. On the lateral aspect, the surgeon should examine the soft spot, a triangle formed by the lateral epicondyle, the olecranon, and the radial head. Swelling or fullness in this region can indicate joint effusion or synovial proliferation. The posterior region is examined next. Swelling or a prominence in this region may indicate olecranon bursitis, traction spur, or nodules from gout or rheumatoid arthritis. Swelling or fullness medially may indicate an avulsion fracture of the medial epicondyle or a UCL injury. The anterior region should be evaluated for deformity of the biceps muscle. A more proximal deformity (eg, Popeye deformity) can be indicative of a tear of the proximal long head of the biceps, whereas a more distal deformity can be the result of a distal biceps rupture. Finally, the skin should be inspected for erythema, which can be a sign of an infectious or inflammatory process.

Palpation

Following careful inspection, the four regions of the elbow should be palpated in an orderly fashion. The patient's history generally guides the examiner toward a specific location, but palpating all four anatomic regions ensures that concomitant pathology is not missed. Beginning with the anterior structures, the distal biceps tendon is palpated anteromedially within the cubital fossa. To test biceps tendon integrity, the patient's forearm strength should be tested in full supination; elbow strength should be tested in active flexion.[7] Tenderness in the antecubital fossa without a biceps tendon defect may be indicative of biceps tendinitis or a partial tendon rupture, whereas tenderness with a defect is consistent with a complete rupture.

Next, the clinician should palpate the medial region of the elbow, beginning with the medial epicondyle and the flexor-pronator mass. Tenderness in this region can suggest a medial epicondyle avulsion fracture (in adolescents) or medial epicondylitis (in adults). The patient with medial epicondylitis will exhibit local tenderness and pain with resisted wrist flexion and forearm rotation. The UCL courses from the anteroinferior surface of the medial epicondyle and inserts on the medial aspect of the coronoid at the sublime tubercle.[8] It can be palpated under the mass of the flexor pronator origin when the elbow is flexed >90°.[9] Tenderness at this location suggests UCL injury, especially in the throwing athlete.

In the posteromedial region of the elbow, the ulnar nerve is easily palpable in the ulnar groove, which is located between the medial epicondyle and the posteromedial olecranon. The examiner should palpate for a Tinel sign in three areas: proximal to the cubital tunnel, at the level of the cubital tunnel, and distal to the cubital tunnel.[10] A positive test produces paresthesia in the fifth digit and in the ulnar-innervated region of the fourth digit, suggesting a diagnosis of ulnar neuritis or cubital tunnel syndrome. The examiner should also test the nerve for hypermobility. This is done by palpating the nerve as the elbow is brought from extension to terminal flexion, to determine whether the nerve subluxates or completely dislocates over the medial epicondyle.[10]

In the posterior region of the elbow, the olecranon bursa is examined for swelling or fluctuation. The medial subcutaneous border is palpated for tenderness, which, in the throwing athlete, can be caused by a stress fracture.[11] Palpation of the posteromedial olecranon can reveal osteophytes and swelling, which are present in the throwing athlete with valgus extension overload syndrome.[6] The triceps insertion is examined last; tenderness here may indicate triceps tendinitis or, in the presence of a defect, a frank rupture.

Examination of the lateral region of the elbow begins with palpation of the lateral epicondyle. Tenderness directly over the lateral epicondyle is indicative of lateral epicondylitis. The radial head and radiocapitellar joint just distal to the epicondyle are palpated next. Pronation and supination of the forearm can aid in finding the joint line. Tenderness or crepitus in this area can indicate a fracture, OCD, Panner disease, or articular fragmentation. In the young athlete, such fragmentation can progress to loose body formation.[12] Finally, the soft spot is palpated to evaluate for joint effusion.

Range of Motion

In the elbow, range of motion (ROM) occurs in two planes: flexion and extension, and pronation and supination. ROM in the injured elbow should be determined and compared with that of the contralateral extremity. Active and passive ROM of the elbow and forearm (ie, flexion-extension, pronation-supination) should be measured with a goniometer, taking note of discrepancies between active and passive motion.

With respect to flexion and extension, a functional arc of 120° is necessary for activities of daily living; an extension deficit >30° or flexion <130° are considered abnormal.[13] Lack of full extension in an acute situation has been shown to be 97% sensitive in diagnosing a significant bone or joint injury; thus, in the patient with full extension of the elbow after an acute injury, the chance is very low that a significant injury has occurred.[14] Lack of elbow flexion may be caused by loose bodies, radial head or capitellar fracture, triceps strain, and anterior osteophytes.

The functional arc of motion for both pronation and supination is 50°.[13] Loss of pronation or supination can be caused by loose bodies, radiocapitellar osteochondritis, synovitis, and radial head fracture.[7] The wrist should also be assessed because wrist injury can cause loss of forearm rotation. The examiner must note the presence or absence of crepitus or popping during both active and passive ROM as this may also indicate joint pathology.

Stability Testing

Stability of the elbow should be assessed in both flexion and extension. The elbow joint is inherently stable as a hinge joint, with the ligamentous support of the elbow providing approximately one half of joint stability. The most common patterns of instability in the elbow are valgus instability secondary to attenuation or rupture of the anterior bundle of the UCL, and posterolateral rotatory instability secondary to lateral UCL insufficiency. The manual valgus stress test is performed with the elbow flexed 20° to 30° and the arm secured between the examiner's arm and trunk. With the forearm in maximal pronation, valgus stress is then applied to the elbow. Any increased opening or reproduction of the patient's pain with valgus stress may be indicative of injury to the UCL.[2]

Posterolateral instability is assessed using the lateral pivot shift apprehension test as described by O'Driscoll.[15] The patient is placed supine, with the affected extremity positioned overhead. The wrist and elbow are held in a fashion similar to that of the ankle and knee during a knee examination. The forearm is supinated, and a valgus-to-varus moment and compressive force are applied to the elbow during flexion. Apprehension and a reproduction in symptoms indicate a positive test. The posterolateral rotatory instability test may elicit posterolateral subluxation or dislocation of the radius and ulna from the humerus.

Stability stress testing and other provocative maneuvers (Table 1)[16-18] must be performed with the patient relaxed. Local or intra-articular injection of lidocaine or bupivacaine may be required to appreciate the joint pathology.

Imaging Studies

Anteroposterior, lateral, and oblique plain radiographic views of the elbow should be obtained to evaluate previous fractures, joint degeneration, osteophytes, loose bodies, and malalignment. Stress views are helpful in assessing ligamentous laxity. Olecranon axial views may reveal medial osteophytes in valgus extension overload syndrome.[6] Osteochondral lesions appear as radiolucent lesions of the capitellum and may be indicative of sclerosis of the underlying subchondral bone. In some patients, irregularity of the radial head is associated with the capitellar lesion. Contralateral comparison imaging studies of the elbow are helpful when evaluating elbow joint laxity and when trying to distinguish true growth disturbances from variant ossification centers in the pediatric population.

Magnetic resonance imaging (MRI) is important in assessing soft-tissue and cartilage. The integrity of the collateral ligaments also can be assessed with MRI. The medial collateral ligament must be assessed in the throwing athlete being evaluated for valgus extension overload syndrome.[19] MRI is an important study for identifying tears of the lateral collateral ligament complex and the extensor carpi radialis brevis muscle. Magnetic resonance arthrography with either saline or gadolinium is more sensitive than MRI for detecting undersurface tears of the UCL.[20] OCD lesions may not be visible on plain radiographs, but MRI may show a low signal in lesions attached to the subchondral bone and a high signal in lesions detached from underlying subchondral bone.[21]

Table 1

Provocative Maneuvers of the Elbow

Pathology	Test
Osteochondritis dissecans	Radiocapitellar compression test: place the elbow in full extension and load with supination and pronation to produce mechanical symptoms.[16]
Valgus extension overload	Clunk test for posterior olecranon impingement: after the upper arm is stabilized, the elbow is brought to extension to produce posterior elbow pain.[6]
Ulnar collateral ligament insufficiency	Moving valgus stress test: apply a valgus stress to the elbow in the flexed position and then quickly extend the elbow. A positive test produces medial pain, typically between 120° and 70° of flexion, as a result of shear stress on the ulnar collateral ligament.[9]
Plica	Flexion-pronation test: place the forearm in maximum pronation and passively flex the elbow to 90° to 110° to cause snapping.[17]
Lateral epicondylitis	Chair test: with the patient standing behind the chair, he or she is asked to lift it with the elbow extended, forearm pronated, and wrist dorsiflexed.[18]

Indications and Contraindications

Indications for elbow arthroscopy include removal of loose bodies, excision of olecranon osteophytes, synovectomy, capsular release, and the assessment and treatment of OCD of the capitellum.[1,5,21,22] Recent developments in improved techniques and instrumentation for elbow arthroscopy have allowed the expansion of indications to include extensor tendon débridement for lateral epicondylitis, plica excision, and fracture management.[17,22-26]

The primary contraindication to elbow arthroscopy is any change in the normal bony or soft-tissue anatomy that precludes safe entry of the arthroscope into the elbow joint.[26] In general, we do not recommend performing arthroscopy when there has been a previous ulnar nerve transposition or when adequate distension of the joint cannot occur (eg, ankylosed joint). Arthroscopy should not be done in the presence of local soft-tissue infection in the area of the portal sites.

Surgical Set-up

Anesthesia

Regional or general anesthesia may be used for elbow arthroscopy. Regional anesthesia, with or without intravenous sedation, includes interscalene block, axillary block, and Bier block. The advantage of regional anesthesia is that it optimizes postoperative pain control, minimizes postoperative nausea, and facilitates positioning in cooperation with the patient. The main disadvantage of regional anesthesia is the inability to perform a postoperative neurologic examination of the involved extremity to determine whether nerve injury has occurred. In our work with experienced regional anesthesiologists, we have not had any cases of nerve damage after interscalene block. Thus, we usually recommend regional anesthesia for elbow arthroscopy. We typically use axillary block anesthesia with intravenous sedation because it maximizes patient tolerance, and it allows for supine positioning and maximizes postoperative comfort.

The advantages of general anesthesia include various options for patient positioning and total muscle relaxation. Disadvantages include the potential for greater postoperative pain and a longer postanesthesia recovery.

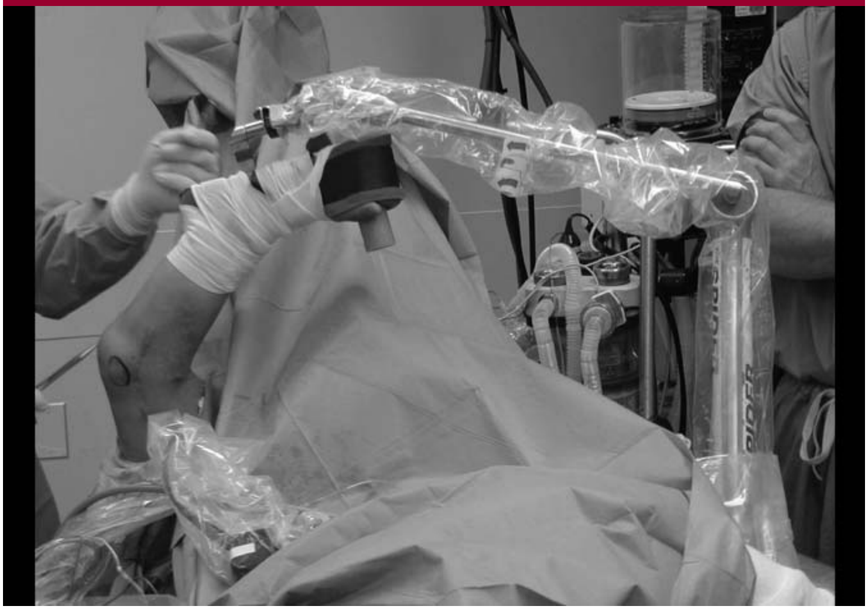
Instrumentation

The arthroscopic systems used in the larger joints (eg, shoulder, knee) are also used in the elbow. Arthroscopy pumps are designed to control irrigation and distention of the joint by maintaining a selected pressure and fluid flow rate. We currently use the 3M arthroscopy pump (3M Health Care, St Paul, MN) because it automatically decreases flow when the pressure increases over the preset value and stops if the pressure gets too high. When the pressure returns to the desired range, the pump will automatically start fluid flow to avoid loss of distension. The 3M pump enables improved visibility by selectively increasing pressure when more aggressive bleeding occurs.

We use a standard 4.0-mm arthroscope (Dyonics; Smith & Nephew, Andover, MA) with a 30° angled lens and arms for both fluid inflow and suction outflow. A smaller 2.7-mm arthroscope can also be used to view small spaces, but it is rarely needed. It is important to use elbow cannula systems that are compatible with both the 4.0- and 2.7-mm arthroscopes because doing so allows the surgeon to switch viewing and working portals without repeated penetration of the elbow capsule. This results in decreased fluid extravasation and may prevent injury to neurovascular structures.

All trocars should be conical and

Figure 1



The modified supine position for elbow arthroscopy. This position, with the arm suspended over the chest, helps to facilitate patient positioning and allows for conversion to an open position, if necessary, as well as easy manipulation of the arm. The Spider hydraulic arm holder (Spider Limb Positioner, Tenet Medical Engineering, Calgary, Alberta, Canada) is used to suspend the limb.

blunt-tipped to avoid neurovascular and articular cartilage injury. We typically use a combination of handheld instruments (eg, probes, graspers, pointed awls, curved osteotomes) as well as motorized instruments (eg, synovial resectors, radial end-cutting shavers, burrs).

Patient Positioning

The supine-suspended position, originally described by Andrews and Carson,[1] positions the shoulder in 90° of abduction, with the elbow flexed 90° and the forearm, wrist, and hand suspended by a mechancial traction device. We use a modification of this position, with the shoulder flexed 90° such that the forearm is suspended over the chest.

Several mechancial arm holders are available, including the McConnell arm holder (McConnell Orthopaedic Manufacturing, Greenville, TX) and the Spider hydraulic arm holder (Spider Limb Positioner, Tenet Medical Engineering, Calgary, Alberta, Canada). The Spider hyraulic arm holder more rigidly suspends the arm in space and can be easily adjusted to allow for any desired changes in position (Figure 1). Because the position of the arm can be adjusted in space, the anterior and posterior compartments can both be easily accessed. In addition, with the arm flexed over the chest, the anterior neurovascular structures effectively drop away from the anterior capsule, thus making work on the anterior compartment easier and safer. Furthermore, with the patient positioned supine, the anesthesiologist has excellent access to the airway. Should there be a need for open surgical intervention (ie, arthrotomy), the arm can be removed from the holder and placed across the arm board, where the seated surgeon can progress with an open surgical procedure.

We have found this technique to be very successful and have not experienced the disadvantages that have been described, such as arm instability, difficult orientation, and poor access to the posterior compartment.[27] A tourniquet should be placed around the proximal aspect of the arm, but it should be inflated only when blood loss impairs arthroscopic visualization.

Initially, elbow arthroscopy is performed with the patient in the supine position and with the arm placed on an arm board and laid across the body. This position, termed the "standard supine position," has been largely replaced by the supine-suspended position.

The prone position was first described by Poehling et al.[28] The patient is positioned prone on chest rolls, and the arm is stabilized by an arm holder and allowed to hang off the table. The shoulder is abducted to 90°, and the elbow is flexed to 90°. Some surgeons prefer this position because it eliminates the need for traction, places the elbow in a more stable position, and allows easier access to the posterior aspect of the joint.[22,28] This position also may allow for conversion from arthroscopy to an open surgical procedure, if necessary.[22] The main disadvantages of the prone position are that general anesthesia is required because of the prone patient positioning and that there is poor access to the airway by the anesthesiologist.

The lateral decubitus position, originally described by O'Driscoll and Morrey,[29] has advantages similar to those of the prone position, including improved arm stability and posterior joint access. However, access to the airway is not compromised. Its main disadvantage is that access to the anterior compartment may require repositioning. The patient is positioned lateral, with the shoulder flexed forward at 90° over a padded bolster.

Portal Placement

Several portals have been described for elbow arthroscopy. Some of the most common portals utilized are the anterolateral, midlateral, an-

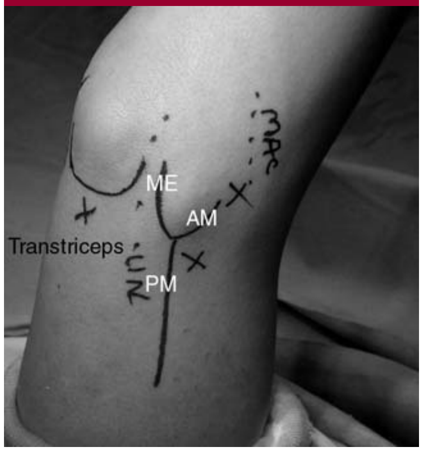
Figure 2

A

B

Lateral **(A)** and posterior **(B)** views demonstrating the portals the authors use most commonly, which are marked with an "X:" the midlateral (ML), or "soft spot portal;" proximal lateral (PL); posterolateral (PoL); and transtriceps. These portals are located in relation to the lateral epicondyle (LE). The radial nerve (dotted line in panel A) is carried away from the proximal lateral portal in flexion when the joint is distended. The dotted line in panel B represents the ulnar nerve.

Figure 3



Posterolateral view of the proximal medial (PM) portal, which is located 2 cm proximal and 1 to 2 cm anterior to the medial epidcondyle (ME). When creating this portal, it is important to stay anterior to the medial intermuscular septum. The anteromedial portal (AM) is located 2 cm anterior and 2 cm distal to the medial humeral epicondyle. This portal is in close proximity to the medial antebrachial cutaneous nerve (MAC) and should be established first by spinal needle localization.

teromedial, proximal medial, proximal lateral, and straight posterior.[26] We most commonly use the midlateral, proximal lateral, posterolateral, and transtriceps portals (Figures 2 and 3).

Surgical Technique

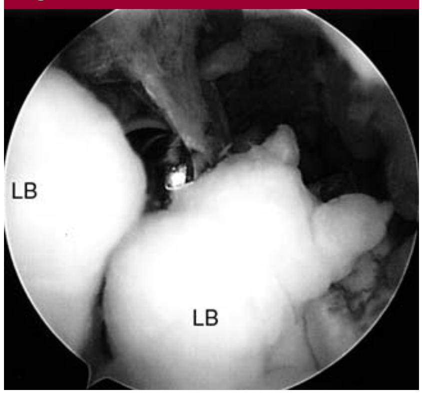
After anesthesia administration and patient positioning, the elbow joint is insufflated with 20 to 30 mL of saline, which is injected through the soft spot in the midlateral portal. Distending the joint in this fashion shifts the neurovascular structures away from the penetrating instruments and facilitates the safe entry of the instruments. It is important to avoid overdistension of the capsule, which can ultimately lead to capsular rupture and an inability to effectively maintain adequate fluid pressure for the ensuing arthroscopy.

Anterior Arthroscopy

The arthroscope is introduced through the proximal lateral portal into the anterior compartment. A diagnostic arthroscopy is then performed anteriorly to evaluate the articular cartilage and synovium and to look for loose bodies (Figure 4). The coronoid process is examined for the presence of bone spurs, and the anterior trochlea and coronoid fossa are examined for cartilage lesions (Figure 5). The anterior radiocapitellar joint is evaluated for osteochondral lesions of the capitellum and any matching pathology of the radial head. It is very important to keep in mind that the radial nerve lies on or within a few millimeters of the anterolateral joint capsule; thus, débridement in this area requires extreme caution.

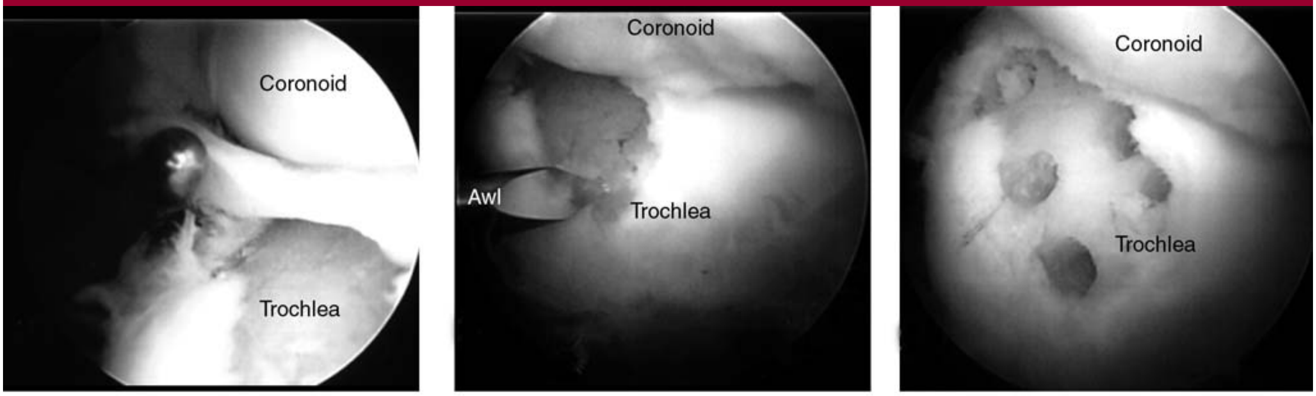
In cases in which medial collateral ligament insufficiency is suspected, the arthroscopic valgus stress test is done during assessment of the anterior compartment. With the arthroscope in the proximal lateral portal visualizing the medial compartment, valgus stress is applied. A gap between the ulna and the humerus >3 mm is consistent with UCL insufficiency (Figure 6). When a proximal medial portal has been established, a probe of a known size can be inserted through this portal to aid in the measurement of

Figure 4



Intraoperative photograph demonstrating loose bodies (LB) in the anterior compartment of the elbow joint. In this view, the arthroscope is in the proximal lateral portal, and a grasper is seen entering the anterior compartment via the proximal medial portal.

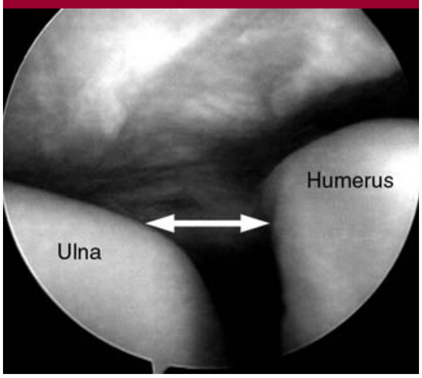
Figure 5



A **B** **C**

A, Intraoperative photograph demonstrating an articular cartilage lesion of the trochlea in the anterior compartment. Débridement of the lesion helps determine the precise size of the lesion as well as the location and quality of the surrounding "shoulder of cartilage." The arthroscope is in the proximal lateral portal; the anteromedial portal is the working portal. **B,** Once the loose, unstable flap has been débrided, marrow stimulation techniques (eg, microfracture) may be performed. We prefer to use a pointed awl. **C,** Completion of the microfracture technique.

Figure 6



Arthroscopic anterior view of the medial elbow with valgus stress applied. Note the excessive ulnohumeral opening (double-headed arrow), which is indicative of ulnar collateral ligament insufficiency.

the ulnohumeral opening. If such a portal is not available, then the amount of valgus opening can be estimated. When work needs to be done in the anterior compartment, such as with removal of loose bodies, capsular release, synovectomy, or débridement, a proximal medial portal is established under direct visualization.

Posterior Arthroscopy

Following completion of the anterior arthroscopy, a posterolateral portal is established. The camera is switched from the anterior cannula and inserted into this portal. We typically maintain the anterior cannula to faciliate reentry into the anterior compartment, in case that is necessary.

The medial, lateral, and central olecranon are evaluated for the presence of osteophytes. The corresponding olecranon fossa and posteromedial aspect of the humeral condyle are evaluated for matching chondral defects. The posterior radiocapitellar joint is evaluated by advancing the arthroscope down the lateral gutter.

Common Conditions That Are Treated Arthroscopically

Loose Bodies

Removal of loose bodies from the elbow joint is the most commonly performed arthroscopic therapeutic intervention.[25] Loose bodies are often osteochondral or chondral fragments that are the result of a traumatic insult or underlying pathology, such as OCD within the elbow joint. The patient will often report catching, clicking, swelling, or loss of motion. Most loose bodies are evident on plain radiographs. It is often difficult to determine the exact location of loose bodies because they can migrate between compartments; thus, it is crucial to perform a complete diagnostic arthroscopy (Figure 7).

Andrews and Carson[1] demonstrated that removal of isolated loose bodies from the elbow was the most successful arthroscopic therapeutic intervention. Others have shown that patients who undergo removal of loose bodies associated with OCD lesions improve significantly, whereas patients who have loose bodies removed for osteoarthritis have minimal improvement.[30] Ogilvie-Harris and Schemitsch[30] reported that pain was relieved in 85%, swelling in 71%, and locking and catching in 92% of 34 patients who underwent arthroscopic removal of loose bodies.

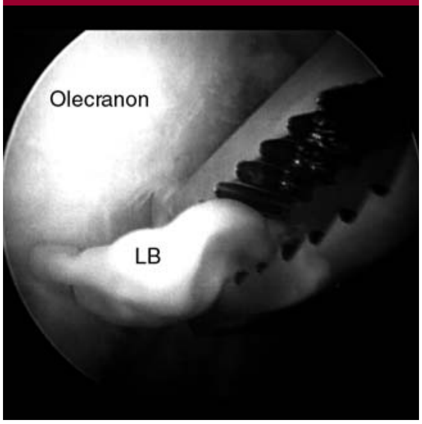
Arthroscopy in the Thrower's Elbow

The throwing athlete is subject to a variety of intra-articular pathology as a result of the tremendous repetitive valgus forces that are generated during the acceleration and follow-through phases of pitching. As the elbow goes into extension, these resulting forces can lead to osteochondral changes of the olecranon and distal humerus. This process has been dubbed "valgus extension overload."[6] The most common problem encountered in this population is a fragmented spur on the posteromedial olecranon as a result of posterior shear stresses seen in valgus extension overload. Such spurs are typically evident on plain radiographs (Figure 8) and MRI scans.

Initial treatment should include a period of rest as well as nonsteroidal anti-inflammatory drugs (NSAIDs) and gradual return to play. If these measures fail, the surgeon may proceed with arthroscopic evaluation and resection of the posteromedial olecranon osteophyte. With the camera in the posterolateral portal and the shaver in the transtriceps portal, the extent and dimensions of the osteophyte should be determined. Removal of the osteophyte from the posteromedial olecranon may require the use of an osteotome (Figure 9). Once the osteophyte has been removed, the humeral chondral surface can be evaluated for lesions. In general, we débride loose chondral flaps and use microfracture techniques for full-thickness chondral defects that have a stable surrounding rim of cartilage.

The optimal amount of olecranon resection remains unclear, but we generally try to limit the resection to the osteophyte only and preserve as much native bone as possible because of the potential for elbow instability with excessive bone resection.[31,32] Additionally, it is very important not to miss an underlying UCL injury when diagnosing and treating this problem. Andrews and Timmerman[33] studied 72 professional baseball pitchers treated with arthroscopic or open elbow procedures. Those who underwent removal of posteromedial olecranon osteophytes had the highest rate of revision, with 38.5% requiring subsequent UCL reconstruction. The authors' explanation for this revision rate was that either the injury to the ligament was not recognized initally or that excessive débridement of the osteophyte led to valgus laxity.

Figure 7

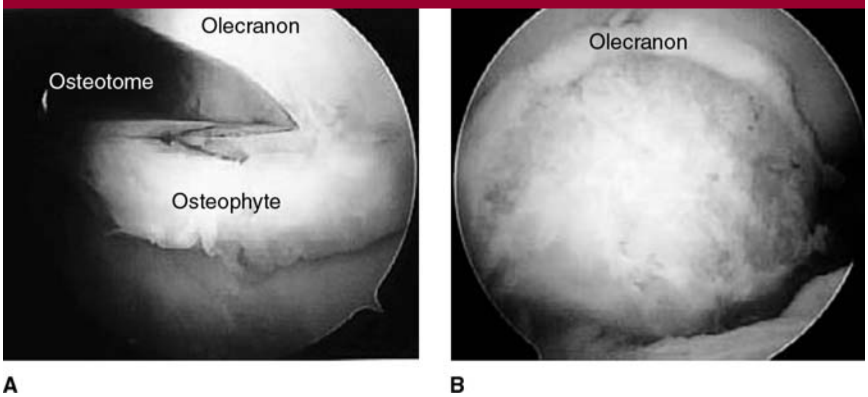


Arthroscopic view of a loose body (LB) being removed from the posterior compartment of the elbow. The arthroscope is in the posterolateral portal, and the grasper is working through the transtriceps portal.

Figure 8

Lateral radiograph demonstrating an osteophyte on the posterior olecranon (arrow).

Figure 9

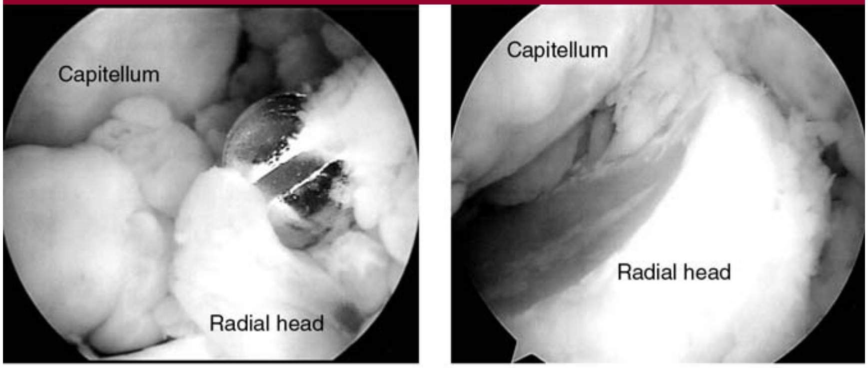


A, Intraoperative photograph demonstrating arthroscopic removal of a posteromedial olecranon osteophyte with a curved osteotome. Care should be taken to remove only the osteophyte and to retain as much native bone as possible in order to avoid iatrogenic medial collateral ligament insufficiency. In this view, the arthroscope is in the posterolateral portal, and the osteotome has entered the joint via the transtriceps portal. **B,** Photograph taken following osteophyte resection.

Synovectomy

Synovectomy is typically performed for conditions that cause a generalized synovitis, the most common of which are rheumatoid arthritis (Figure 10) and synovial chondromatosis. The elbow joint is affected in as many as 50% of patients with rheumatoid arthritis; many of these

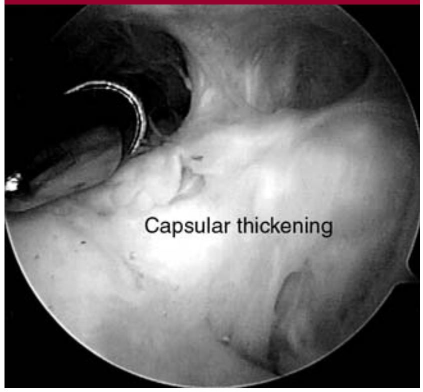
Figure 10



A B

A, Arthroscopic view of a patient with rheumatoid arthritis who had extensive synovitis of the anterior compartment. A shaver has been inserted into the radiocapitellar joint via the anteromedial portal. **B,** Intraoperative photograph demonstrating identification of the radiocapitellar joint after extensive synovectomy.

Figure 11



Arthroscopic view of extensive adhesions in the anterior compartment in a patient with posttraumatic arthrofibrosis. These are some of the most difficult cases because of the inability to distend the capsule and push the neurovascular structures away from the penetrating trocars and instruments.

patients will develop pain and loss of motion.[34]

Nonsurgical management consists of a trial of medical management, including NSAIDs, disease-modifying antirheumatic drugs, and oral cortiscosteroids. For patients who do not respond to nonsurgical treatment and who have minimal articular cartilage destruction, arthroscopic intervention is indicated. Compared with open synovectomy, arthroscopic synovectomies achieve excellent short-term results; however, the results deteriorate over time. Lee and Morrey[34] achieved 93% excellent or good results at short-term follow-up in 14 arthroscopic synovectomies (11 patients). However, only 57% of the patients maintained excellent or good results at an average of 42 months after surgery.

Clarke[35] also described performing an arthroscopic synovectomy for an inflamed symptomatic lateral synovial fringe (ie, plica). In each case, patients presented with symptoms of loose bodies but did not have loose bodies at the time of arthroscopy. Instead, each patient had synovial plica that impinged between the radial head and the capitellum. Other authors have reported similarly good results following arthroscopic synovectomy to manage symptomatic lateral synovial plicae.[17,36]

Ostechondritis Dissecans and Panner Disease

OCD of the capitellum is typically characterized by pain, swelling, and decreased ROM that usually occur in a throwing athlete or gymnast. The underlying cause is thought to be repetitive microtrauma to a vulnerable epiphysis with a precarious blood supply.[37] Panner disease is an osteochondrosis that involves the entire capitellum; it is usually self-limiting and tyically resolves with rest.[37]

Indications for arthroscopic surgery include failure of nonsurgical management, the presence of loose bodies, and a locked elbow. The arthroscopic procedure centers on retrieval of loose bodies, débridement of loose cartilage flaps, and, when indicated, percutaneous microfracture techniques.[38]

Arthrofibrosis

The loss of elbow joint motion may result from bone or soft-tissue pathology. Trauma as well as degenerative or inflammatory arthritides can lead to arthrofibrosis. Inital management should include NSAIDs, stretching, and splinting to help restore motion. When these modalities fail, an arthroscopic release is indicated. It is very important to be aware that an affected joint will not distend because of the reduced compliance of the capsule and, therefore, the procedure becomes technically demanding, with an increased complication rate.

Typically, the joint capsule is released from its anterior humeral attachment along with any adhesions in the radiocapitellar joint area (Figure 11). When posterior scarring is associated with osteophyte formation, posterior débridement with removal of osteophytes is performed.[25] Postoperatively, the patient is splinted in full extension and supination for 2 days, at which point active and passive ROM are initiated.

Timmerman and Andrews[39] reported good to excellent results in 79% of 19 patients who underwent arthroscopic débridement for posttraumatic elbow stiffness. Extension improved from a mean of 29° to 11°, and flexion motion changed little, from an average of 123° to 134°. Other authors have reported a similar mean improvement in elbow ROM after arthroscopic release and débridement.[40,41]

Osteoarthritis

Arthroscopic treatment of osteoarthritis of the elbow can be successful in the early stages by removing loose bodies and osteophytes from the olecranon and the coronoid process.[42] However, the effectiveness of arthroscopy is much less predictable when the disease has progressed significantly within the elbow joint. Ogilvie-Harris and Schemitsch[30] successfully treated 21 patients who had posterior impingement associated with degenerative elbow arthritis. The authors used anterior débridement and removal of loose bodies, followed by posterior removal of loose bodies and removal of osteophytes from the posterior olecranon and olecranon fossa.

Lateral Epicondylitis

Initial management of lateral epicondylitis (ie, tennis elbow) should consist of rest, ice, protective splints or braces, avoidance of provocative activities, and NSAIDs. Steroid injections also can provide symptomatic relief. When nonsurgical management fails, direct or indirect surgical treatment is indicated. The underlying pathology in lateral epicondylitis is injury to the extensor carpi radialis brevis tendon secondary to repetitive microtrauma. Over time, this chronic inflammatory process may ultimately lead to microscopic tears and frank rupture of the tendon, causing pain on the lateral aspect of the elbow.[43] Historically, an open surgical procedure has been done in which the diseased portion of the tendon is removed with repair or reattachment of the extensor carpi radialis brevis tendon.[43] We primarily use a percutaneous tenotomy for lateral epicondyltis, as reported by Dunkow et al,[44] because it is a relatively easy technique and has demonstrated results superior to those of the open procedure with regard to return to work; disabilities of the arm, shoulder, and hand scores; high-demand work scores; and subjective outcome.[44]

Arthroscopic release offers several potential advantages over open techniques. It preserves the common extensor origin, allows for intra-articular examination for other possible pathology (eg, loose bodies, inflamed synovium, plica chondral lesions), and permits a shorter postoperative rehabilitation period, resulting in earlier return to work or sports.[45]

Baker and Jones[45] described a technique for arthroscopic release. With the middle anterolateral portal used for instrumentation, the joint capsule is resected at the lateral epicondyle and the lateral condylar ridge. The lateral epicondyle and distal portion of the lateral condylar ridge are then decorticated. These authors reported symptomatic improvement at 1-year follow-up in 33 of 35 patients treated with arthroscopic release for lateral epicondylitis. Of the patients who were able to return for grip-strength analysis, the grip strength of the affected limb averaged 96% of the strength of the unaffected limb.[46] Other authors have reported similar success using arthroscopy to treat lateral epicondylitis.[23,47]

Complications

The safety of elbow arthroscopy has dramatically improved as clinical and cadaveric studies have increased our understanding of portal placement and the relative positions of surrounding neurovascular structures. Most complications of elbow arthroscopy are neurovascular in nature.[48-51] Injury can be caused by direct laceration from a knife penetrated deep to the skin or from the cannula trocar. Additionally, compression from a cannula, from fluid extravasation, or from the use of local anesthetics has also been reported.[29] Fortunately, most of these injuries are transient, but there have been reports of complete neurologic injury (eg, of the radial nerve). Haapaniemi et al[51] reported on a case of complete transection of the median and radial nerves during arthroscopic release of a posttraumatic elbow contracture. Many of the attenuated portals described in the literature place surrounding neurovascular structures at a higher risk than do the portals described above (ie, midlateral, proximal lateral, posterolateral, transtriceps). Therefore, we recommend use of these arthroscopic portals for safety and optimum visualization.

Other complications of elbow arthroscopy are similar to those reported for arthroscopy in general. These include infection, articular cartilage injury, synovial fistula formation, instrument breakage, and tourniquet-related complications.[29]

Many of the complications associated with elbow arthroscopy are the result of inexperience, poor technique, and lack of knowledge with regard to the anatomy about the elbow. Thus, it is crucial that the surgeon who wishes to perform elbow arthroscopy safely and effectively adhere to strict surgical technique and portal placement to avoid preventable complications. In every clinical case, the bony anatomy should be drawn on the patient's elbow, an 18-gauge spinal needle should be used to confirm the correct portal location before introducing larger arthroscopic instruments, and the elbow should be maximally distended at all times to displace the neurovascular structures away from the entering instruments. Complications of elbow arthroscopy can also be avoided with proper patient selection and indications.

Surgeon training and experience are crucial to the success of elbow arthroscopy. Orthopaedic surgeons should proceed with elbow arthroscopy after appropriate training and, perhaps, working with an experienced surgeon. The American Academy of

Orthopaedic Surgeons and the Arthroscopy Association of North America both fund and support annual lectures, hands-on workshops, and numerous publications dedicated to the art of elbow arthroscopy.

Summary

Elbow arthroscopy is an important tool in the diagnosis and management of numerous injuries to the elbow joint. It is still probably most successful in the removal of loose bodies, for treating an assortment of osteochondral injuries, and in helping to restore motion in selected patients. The preoperative evaluation should focus on a complete history and physical examination to aid in diagnosis. The diagnosis and understanding of related pathology, which should be confirmed at the time of surgery and portal placement, are crucial to ensure a successful procedure. Although there are still many clinical situations in which an open procedure is warranted, recent advances in the understanding of the anatomy and biomechanics of the elbow, combined with the development of sophisticated techniques for elbow arthroscopy, allow for the successful treatment of many common conditions of the elbow.

References

Evidence-based Medicine: Two level II randomized controlled studies are cited (34 and 44). Several level III/IV case-control and cohort studies are cited (13-17, 19-21, 23, 24, 30-33, 35, 36, 38-43, and 46-51). The remainder are level V expert opinion.

Citation numbers printed in **bold type** indicate references published within the past 5 years.

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