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SYMPOSIUM

Elbow Arthroscopy for Posttraumatic Arthrosis

Timothy M. Geib, MD
Felix H. Savoie III, MD

Abstract

Posttraumatic stiffness is a common complication after injury to the elbow. The loss of motion may significantly limit an individual's ability to perform normal activities of daily living. If conservative measures including medication, physical therapy, static splinting, and selective injection fail to restore functional range of motion, surgical intervention may be warranted. Open procedures have been described with reasonable success in restoring motion. However, arthroscopic techniques may provide several advantages in these patients who have often undergone previous extensive open surgery.

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The elbow is a highly complex joint that acts as a link for the body to adjust the hand in space. The elbow has three articulations. The ulnohumeral joint is responsible for flexion and extension, normally 0° to 145°. The radiocapitellar joint is responsible for pronosupination, normally from 90° pronation to 90° supination, and is a secondary stabilizer. The proximal radioulnar joint in conjunction with the distal radioulnar joint maintains the appropriate relationship between the ulna and radius throughout their various motion arcs. The distal humerus is anteriorly angulated 30°, internally rotated 5° to 7°, and is in 6° to 8° of valgus.[1] The soft-tissue structures surrounding the elbow are just as intricate. The anterior capsule is taut in extension, whereas the posterior capsule is taut in flexion.

As a result of these complex anatomic interactions, even a relatively minor injury can result in significant dysfunction caused by stiffness despite satisfactory management of most traumatic bony or soft-tissue injuries. These often minor elbow injuries may be debilitating because of pain, weakness, and lengthy recovery time. The development of a nonfunctional arc of motion certainly worsens the prognosis for full recovery of function. Morrey and associates[2] described a functional arc of motion as 30° short of terminal extension to 130° of flexion and 50° of pronation and supination. Recovery of this functional arc is critical to resuming normal function.

Elbow stiffness is one of the most common complications after injury to the elbow. The normally thin capsule responds to the traumatic intra-articular hemarthrosis as a chemical irritant. This leads to capsular thickening, brachialis cocontracture, and ultimately loss of motion.[3,4] The pathophysiology surrounding posttraumatic joint contracture development is multifactorial. Prolonged joint immobilization leads to progressive contracture of the capsule and pericapsular tissues, intra-articular fibrofatty connective tissue encroachment, articular cartilage fibrillation, and mesenchymal invasion of the subchondral plate. At the cellular level, there is increased collagen in the areolar tissues, decreased water and glycosaminoglycans in the ground substance, and alterations in collagen cross-linking.[5-8] Transforming growth factor-β1 also has been implicated in scar tissue contracture formation in vivo.[9]

Classification

Two classification systems have been developed to assist in the selection of treatment strategies. The first classification system defines the source of stiffness as intrinsic, extrinsic, or mixed. Intrinsic contractures generally develop after intra-articular fractures as a result of intra-articular adhesions after a healed fracture, loss of articular cartilage caused by avascular changes of the comminuted fragments, and/or gross distortion resulting from inadequate or failed reduction. Extrinsic sources of stiffness are soft-tissue contracture and osseous ankylosis. Mixed contractures are a combination of intrinsic and extrinsic causes and have a worse prognosis.[10,11] A second classification system described by Morrey[10] further delineated the anatomic tissue involved into static components (which are more commonly involved) and dynamic components. Static components consist of the capsule, the capsuloligamentous complex, heterotopic ossification, and articular or surface elements as they relate to surface scarring and incongruity. The dynamic components consist of the surrounding muscle, which in extreme cases may contribute to the static elements. Determining the contribution of each component can assist with selecting the most beneficial treatment.[10]

Clinical Evaluation

Initial evaluation of the contracted elbow begins with a thorough history regarding the original incident and initial management. Previous physical therapy sessions, with an indication of whether benign or painful, and the use of short- or long-term splinting also should be documented. Physical examination should begin with inspection of the skin and soft-tissue envelope. Previous incisions, evidence of prior infection, or scarring from burns can have a substantial impact on treatment options. The treating physician should evaluate range of motion (active and passive) and whether the end point is soft or hard. It is also imperative that elbow stability be tested to evaluate collateral ligament integrity. Finally, it is critical to document a thorough neurologic examination of the affected extremity to ensure that the sensory and motor functions of the median, radial, and ulnar nerves are intact.

Radiographic evaluation should begin with plain radiographs in at least two planes and often an oblique radiocapitellar view. Ulnohumeral and radiocapitellar joint congruity, loose bodies, osteophytes, presence or absence of heterotopic ossification, and retained hardware need to be evaluated. Three-dimensional CT reconstructions are particularly useful for identifying impinging osteophytes and malunion of fractures that may limit motion. MRI also is helpful to identify articular lesions such as osteochondral lesions of the capitellum, in addition to loose bodies and soft-tissue abnormalities.

Treatment

Nonsurgical Management

All patients with a contracted elbow should undergo an extended trial of nonsurgical therapy before surgery is considered. Bupivacaine hydrochloride with or without steroid injections, protected range of motion using a double-hinged elbow brace, and physical therapy including gentle stretching, icing, and joint mobilization may prove to be beneficial.[12,13] Static splinting often is helpful in obtaining a functional arc of motion in the elbow. Caution always should be exercised during therapy to prevent additional capsular damage and worsening of the arthrofibrotic condition.

Surgical Management

Indications and Contraindications

Indications for surgery in an elbow with posttraumatic contracture include functional loss of motion, a cooperative patient, and failure of all forms of nonsurgical management. Relative contraindications to surgery include patients younger than age 14 years, lack of available physical therapy, and a patient who is incapable or unwilling to cooperate with extensive postoperative physical therapy. Both the surgeon and patient should play active roles in the decision to undergo surgical management of the stiff elbow. The etiology of the condition, potential risks, expected results, and possible complications, including the risk of nerve damage, should be thoroughly understood by both the surgeon and the patient before surgical intervention. An open surgical technique can be extremely difficult to perform and is associated with a high risk of nerve injury. Elbow surgery should be done only by experienced arthroscopic surgeons.

Open Surgical Treatment

Several authors have described open surgical release techniques for the correction of elbow flexion contractures, including osteotomy of the medial epicondyle with complete anterior capsulectomy and lengthening of the biceps, the limited lateral approach with a capsulotomy, the limited medial approach, and the extensive posterior approach.[14] Urbaniak and associates[15] reported a decrease in flexion deformity from 48° preoperatively to 19° postoperatively with a lateral approach. Husband and Hastings[16] found that extension improved from a mean contracture of 45° preoperatively to 12° postoperatively and flexion increased from 116° to 129°.

Open surgical release of an elbow flexion contracture produces increased soft-tissue trauma from the dissection, postoperative scarring of the capsule and anterior structures that may add to the risk of contracture recurrence, additional elbow trauma above and below the elbow when an external fixator is used, and potentially increased time before physical therapy can be initiated because of surgical pain and scarring. Additionally, it is difficult to treat the entire intrinsic joint pathology without a combined approach to the elbow.

Arthroscopic Surgical Treatment

In the early 1930s, Burman described the use of an arthroscope in cadaver elbow specimens.[17,18] The use of arthroscopic techniques for the elbow lagged behind the knee and shoulder until the 1980s, when Andrews and Carson[19] and Poehling and associates[20] reported on arthroscopic techniques done with the patient supine or prone. The 1980s to 1990s brought about more work in elbow arthroscopy, with pioneering articles by O'Driscoll and Morrey,[21] McGinty,[22] and Baker and Jones.[23] The first reports on the arthroscopic treatment of stiff elbows were by Nowicki and Shall,[24] Jones and Savoie,[25] and Byrd[26] in the early 1990s. As techniques evolved, more reports by Timmerman and Andrews,[27] Ball and associates,[28] and numerous others were presented. The works of O'Driscoll and Savoie and their colleagues spearheaded the advance of improved safety and surgical techniques that led to both improved results and expanded indications. Sporadic reports of neurologic injuries emphasized the need for caution and experience when dealing with these difficult-to-treat conditions.[25,29-33]

In contrast to open release techniques, arthroscopic release allows complete examination and treatment of intrinsic intra-articular joint pathology. Removal of intra-articular adhesions, release of associated scarring, and capsular resection anteriorly and posteriorly can all be accomplished arthroscopically. Evaluation, management, and release of medial and lateral gutter adhesions as well as collateral ligament release also can be accomplished arthroscopically, reducing the risk of recurrence and allowing early initiation of a physical therapy program.

Table 1
Steps in Arthroscopic Management of the Arthrofibrotic Elbow

1. Diagnostic arthroscopy
2. Proximal capsular resection
   a. Medial septum to lateral septum
   b. Expose brachialis
   c. Retract brachialis and neurovascular structures
   d. Complete excision of capsule with nerves and artery protected by both retractors and brachialis
3. Anterior débridement
   a. Resect coronoid if necessary
   b. Remove adhesions
   c. Restore radial fossa or excise radial head
4. Olecranon fossa débridement: elevate triceps tendon
5. Resect olecranon tip
6. Medial gutter débridement: expose and protect ulnar nerve if necessary
7. Lateral gutter débridement: look for loose bodies
8. Olecranon fossa fenestration if indicated

Table 2
Indications for Either Arthroscopic or Open Exploration of the Ulnar Nerve

Preoperative ulnar nerve symptoms
Narrowed cubital tunnel caused by spurs/loose bodies
Previous ulnar nerve surgery of unknown type
Preoperative arc of motion of 30° or less or lack of flexion past 90° (increased risk of tardy ulnar nerve palsy once motion is restored)

Arthroscopic Surgical Technique

Our preferred steps in arthroscopic treatment are outlined in Table 1. The arthroscopic setup for surgical release of the elbow flexion contracture is that of a standard elbow arthroscopy. A 4.5-mm arthroscope and shaver are used, along with standard camera and video recording equipment. The prone position is preferable because it allows better access to both the anterior and posterior capsular structures, but certainly either the lateral decubitus or supine position can be used depending on the surgeon's preference. Initially, an examination under anesthesia is performed, and fluoroscopy should be readily available. A nonsterile tourniquet is applied, and the arm is placed in an arm holder. When scarring is present around the ulnar nerve or the posterior interosseous nerve, the nerve is protected from possible intraoperative damage by using a small-incision surgical approach and a Penrose drain to surround the nerve before arthroscopy is attempted. Indications for taking these steps include anteriorly displaced radial head fractures and anterior heterotopic bone for the posterior interosseous nerve, and large osteophytes and/or extra-articular fragments over the ulnar nerve (Table 2). If deemed necessary by the preoperative evaluation, the posterior interosseous nerve is approached via the transbrachioradialis approach of Lister with minimal damage to the surrounding muscu-

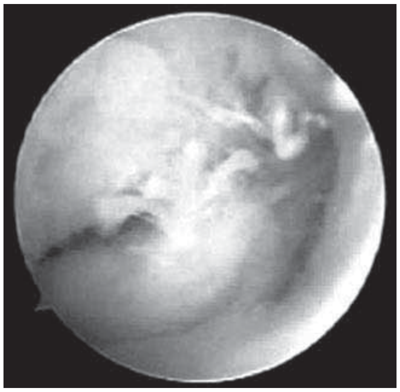

Figure 1 Arthroscopic view of a contracted anterior compartment from the proximal anteromedial portal.

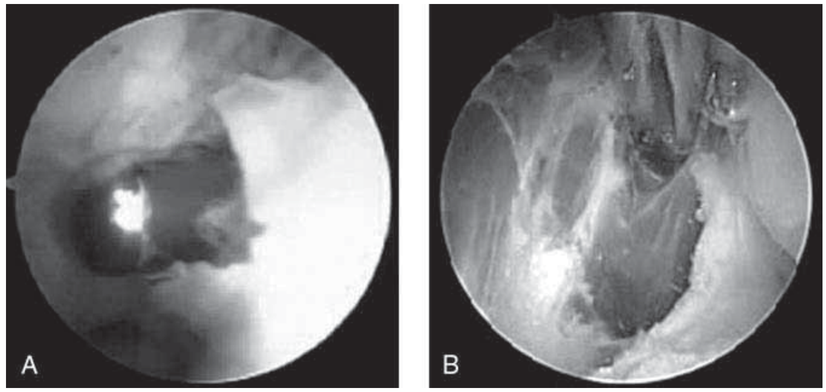

Figure 2 **A,** Arthroscopic débridement of the anterior capsule from the proximal attachment to the humerus. **B,** Brachialis muscle fibers viewed from the lateral portal.

lature. The ulnar nerve is approached through a small incision posterior to the medial epicondyle. In each case, the arthroscopy can still be accomplished but with an increased margin of safety. We usually prefer to attempt to expose the nerve arthroscopically but will use one of the previously mentioned approaches immediately if there is any distortion of anatomy near the course of the nerve.

The initial attempt to insufflate the elbow is made through a standard soft-spot portal, entering the joint between the radial head, the capitellum, and the ulna. A proximal anteromedial portal is then established using only a blunt trocar. The arthroscope is introduced through this cannula, and the anterior compartment of the elbow is evaluated (Figure 1). A proximal anterolateral portal is then established with an outside-in technique. Using proximal portals to begin the procedure adds an anatomic protective factor to assist in the prevention of inadvertent neurologic damage. The more distal anterolateral and anteromedial portals can be established once the joint and anatomy are better defined. These are useful for both retraction and protection. Débridement of the anterior structures is then accomplished, and an anterior capsular excision is done (Figure 2). Excision of the capsule usually begins with the shaver in the medial portal. The capsule is excised beginning with the humeral attachment and continuing distally while remaining on the medial side of the joint until brachialis muscle fibers can be seen (Figure 2, *B*). The dissection progresses back toward the medial septum until the flexor pronator origin can be seen. The excision then continues laterally to the radial side of the joint. The scope is then placed in the medial portal and similarly from proximal to distal the capsule is excised to the lateral extensor muscle origin. The radial nerve is at greatest risk when the capsule is excised just anterior to the radial neck. Often a small fat pad can be seen in this area, and the radial nerve lies immediately anterior to it. Upon completion of the anterior capsulectomy, the brachialis muscle should be visible from the lateral to the medial intermuscular septum. An attempt is made to extend the elbow, and range of motion is evaluated. The bone architecture is then reassessed for the need to restore the radial fossa, excise the radial head, or excise part of the coronoid.

Radial fossa excision is accomplished with the arthroscope in the proximal anteromedial portal and the shaver in the proximal anterolateral portal. The excess bone just above the articular rim of the anterior capitellum is removed until the normal cortex is encountered (Figure 3). Flexion of the elbow will determine if enough bone has been resected to allow full excursion of the radiocapitellar joint.

If radial head excision is necessary, the anterior aspect of the radial head is resected first to avoid penetrating the anterior capsule with possible injury to the posterior interosseous nerve (which lies adjacent to the anterolateral capsule at the level of the radial head and neck). Once the radial head anterior margin has been resected, a protective retractor is placed in the proximal anterolateral portal to sit between the radial head and the anterior capsule to retract and protect the radial nerve. The burr is

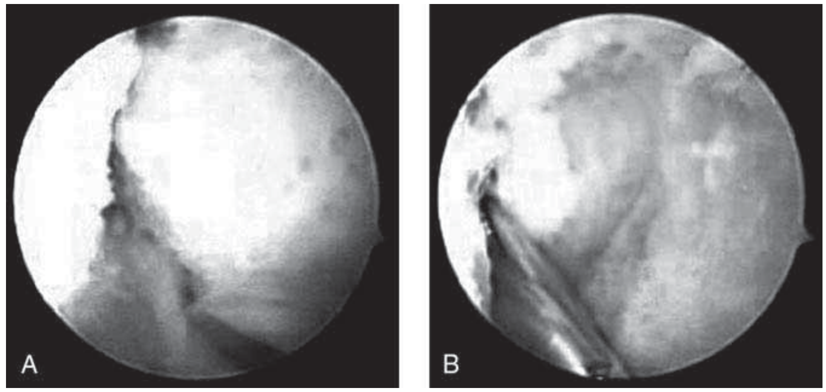

Figure 3 **A,** Radial fossa bone being exposed before excision. **B,** Radial fossa after bone resection. Both views are from the proximal anteromedial portal.

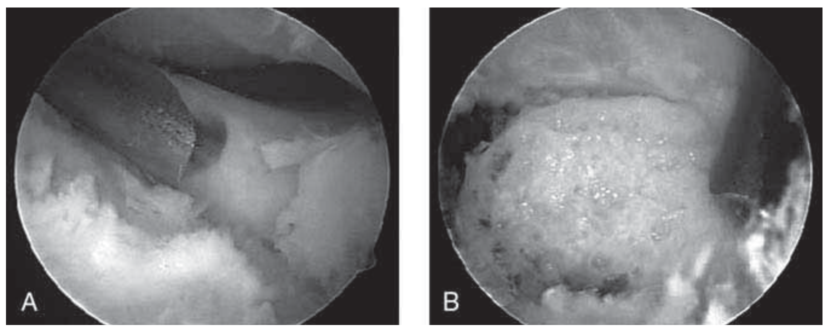

Figure 4 **A,** Arthroscopic view of the radiocapitellar joint before débridement and resection. **B,** Arthroscopic view of radiocapitellar joint after radial head resection. Both views are from the proximal anteromedial portal.

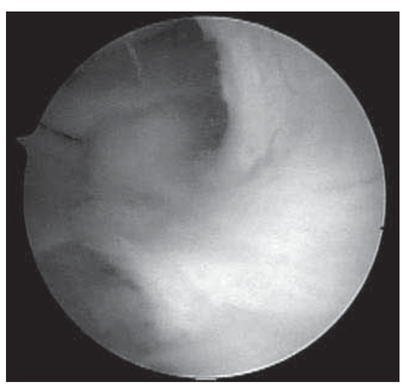

Figure 5 Arthroscopic view of posterolateral plica.

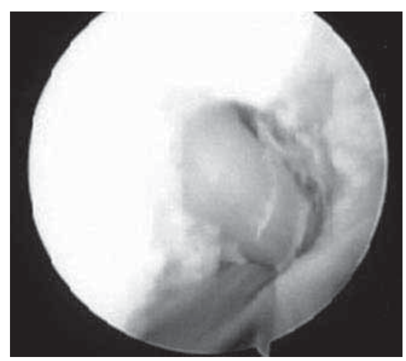

Figure 6 Arthroscopic view of tethered ulnar nerve viewed from the posterocentral portal.

then introduced through the soft-spot portal, and the radial head is coplaned until a complete resection has been accomplished (Figure 4). For isolated radiocapitellar impingement, the proximal 8 to 10 mm of the radial head can be resected; if the proximal radioulnar joint is involved, the entire radial head can be resected.

The surgical focus is then moved to the posterior elbow joint. An inflow cannula is left anteriorly to ensure fluid flow through the gutters and into the posterior compartment. A straight posterior viewing portal is established, along with an accessory posterolateral instrument portal. In the posttraumatically contracted elbow, the fossa usually is full of scar tissue and adhesions that need to be removed to obtain exposure. In most elbows with a posttraumatic contracture, the triceps is attached to the posterior aspect of the humerus by scar tissue and needs to be elevated to allow complete flexion to occur. Once this has been done, attention can be directed more distally to the tip of the olecranon, which may require resection. The medial and lateral gutters are then débrided of all soft-tissue contractures. Initially, the lateral gutter is visualized. If a symptomatic posterolateral plica is present, it is resected (Figure 5). This area of the posterior radiocapitellar joint and the proximal radioulnar joint is a common area for loose bodies and synovitis and must be evaluated in every case. The medial gutter is then débrided, with care taken to protect the ulnar nerve. If resection of the medial aspect of the capsule is required in this area, the ulnar nerve should be identified and carefully protected during the procedure (Figure 6). The elbow is once again placed through range of motion and a decision is made as to whether to proceed with fossa fenestration.

If fossa fenestration is warranted, three 5-mm drill holes are placed in the olecranon fossa, connecting it to the coronoid fossa. These holes are connected using a burr and enlarged until a fenestration of approximately

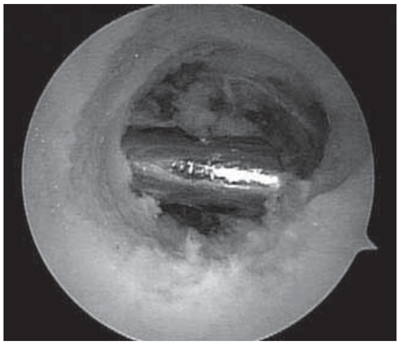

Figure 7 Completed fossa fenestration viewed from the proximal posterolateral portal.

1 to 3 cm in diameter is made (Figure 7). This should allow visualization of the anterior structures through the fenestration and evaluation of the coronoid resection. If necessary, additional resection can be accomplished while viewing from this portal. The tip of the olecranon previously excised is evaluated for adequate medial and lateral resection. This is best accomplished by extending the elbow and checking for impingement of the medial and lateral aspects of the olecranon on the columns of the distal humerus. In most cases, it is this medial and lateral impingement that limits the extension, not the center of the olecranon. The resection for arthritic changes might include as much as 1 to 2 cm. This is in contrast to instability, in which only minimal bone should be removed to decrease the risk of exacerbating the instability. The entire elbow joint is then reevaluated, completing the procedure. Motion is then attempted again; at this time, full flexion and extension should have been achieved. A drain is then inserted anteriorly, and the patient is placed in a soft dressing.

Postoperative Management

After surgery, use of a continuous passive motion machine is initiated in the recovery room and continued for the first 3 weeks. An alternating flexion and extension static-splinting regimen also can be instituted. Compressive cryotherapy is used as well, on a daily basis beginning on the first postoperative day. Daily physical therapy is started the day of surgery for aggressive stretching and strengthening of the elbow. The patient is encouraged to use the arm as aggressively as possible in the immediate postoperative period. Therapy is continued daily for 3 weeks and three times per week thereafter. If loss of motion recurs during the first 3 weeks postoperatively, it is possible to sedate the patient and gently manipulate the elbow to break up the early accumulation of adhesions.

Complications

Complications of this procedure can be significant. The literature has several reports of neurovascular injury, including one case each of permanent posterior interosseous nerve damage and concurrent radial and median nerve injury, as well as sporadic reports of transient or permanent neurologic injury.[25,29] The two largest studies had an approximate 10% complication rate.[30,34] The most common complication was persistent drainage from a portal site. In the Jones and Savoie[25] series, one posterior interosseous nerve injury occurred in the 12th patient, in a series currently comprising more than 300 capsular releases.

Avoiding complications is the key. The surgeon must know the gross and arthroscopic anatomy of the elbow and use retractors liberally. It is imperative to avoid the anteroinferior capsule, place retractors between the shaver and capsule when in this location, and know that injury to the posterior interosseous nerve is increased with radial head fractures. When operating in the anterior compartment, the surgeon should stay close to bone, avoid shaving blindly, and always operate posterior to the brachialis. In the medial gutter, the surgeon should be aware of the ulnar nerve (because it may need open or arthroscopic exposure) and use retractors liberally.

Results

Our results indicate that arthroscopic release is the treatment of choice in most patients with posttraumatic contractures of the elbow. A total of 388 arthroscopic releases have been performed by the senior author (FHS), with an average increase in range of motion from preoperative extension of –40° to –5° at final follow-up; preoperative flexion improved from 105° to 135° postoperatively. Ninety-three percent of patients reported satisfactory results using the Andrews and Carson scale. Ball and associates[35] also reported encouraging results in 14 consecutive patients undergoing arthroscopic capsular release for posttraumatic elbow contracture. These patients were evaluated at more than 1 year after surgery and had an increased mean flexion from 117.5° to 133° and extension contracture improvement from 35.4° to 9.3°. All patients were satisfied with the procedure and had increased American Shoulder and Elbow Surgeons functional ability scores.[35]

Summary

The most common complication after a traumatic injury or surgery in the elbow is loss of motion. The best treatment for this is prevention. When stiffness develops outside the functional range of motion that is refractory to conservative measures, arthroscopic management is becoming the treatment of choice to regain functional arc of motion. A thorough understanding of the gross and arthroscopic anatomy and experience with elbow arthroscopy are necessary. Careful attention to detail must be demonstrated to avoid the devastating neurovascular complications that can occur. A cooperative, motivated patient and aggressive postoperative therapy are necessary to ensure a successful result.

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