Arthroscopy of the Stiff Elbow

John P. Peden, M.D.* and Felix H. Savoie, III, M.D.†

Summary: The pathology of elbow stiffness can be categorized into both intra-articular and extra-articular derangements, which commonly occur in combination. The etiology of the stiff elbow, likewise, can be classified into nonarthritic causes, such as surgery, trauma and certain systemic conditions, and arthritic causes, such as osteoarthritis and rheumatoid arthritis. Current arthroscopic techniques can be used to successfully manage both the arthrofibrotic and the arthritic elbow, when appropriately indicated. This article will review the indications, management principles and arthroscopic techniques for treating the stiff elbow, highlighting anatomic considerations, and the differences in technical guidelines when treating arthrofibrosis versus arthritis.

Key Words: Elbow arthroscopy—Stiff elbow—Elbow arthrofibrosis—Elbow arthritis—Ulnohumeral arthroplasty.

Morrey17 classified elbow stiffness into 2 groups based on etiology and anatomic location of the pathology. Intrinsic contractures are characterized by intra-articular conditions such as degenerative osteophytes, osteochondritis dissecans, articular incongruity, loose and foreign bodies, intra-articular adhesions, and synovitis. Extrinsic contractures are characterized by extra-articular conditions such as scarring of the capsule, collateral ligaments, musculature, and skin. Global conditions affecting muscle, such as heterotopic ossification resulting from neural axis trauma, spasticity from cerebral palsy and tonic conditions from cerebral infarct or neurologic dysfunction also comprise this category. Intrinsic contractures usually have a secondary extrinsic component of either capsular contracture or post-traumatic capsular fibrosis from hemarthrosis and direct injury.35

ASSESSMENT

The distinction between the types of contractures is applicable to a treatment algorithm. Contractures resulting primarily from intrinsic causes may require interventions that address the articular anatomy, whereas, contractures resulting from extrinsic causes may require interventions to soft-tissue structures. Before treatment, all etiologies must be considered, carefully evaluated, and appropriately managed. Management decisions are more appropriately made on the basis of functional limitations than on absolute loss of motion or joint contracture. A functional arc of elbow motion between 30 to 130 degrees is necessary to complete activities of daily living,20 but higher demand vocational and athletic activities may require broader arcs and should be addressed accordingly on an individualized basis.

INDICATIONS

Nonoperative management remains the treatment of choice for the stiff elbow. Nonsurgical modalities that may be effective in improving elbow motion include physical therapy, serial casting, splinting, and manipulation. When functional impairment results from a loss of elbow motion that remains refractory to these more conservative measures, surgical treatment is indicated. Patients with lesser degrees of contracture suffering from...
symptoms that suggest an intra-articular etiology, such as pain, popping, or locking of the elbow, may also be candidates for arthroscopic intervention.

Absolute contraindications to arthroscopy of the stiff elbow include altered neurovascular anatomy that prevents safe portal passage into the joint. Open exploration of these structures, however, can be combined with arthroscopic procedures in these cases. Open exploration of the posterior interosseous nerve, for example, may be required for: 1) anterolateral heteropic ossification and 2) unreduced radial head fractures that penetrate the capsule and brachialis muscle anteriorly. Injury to the nerve is possible with arthroscopic extraction of fracture fragments from this location because of the close proximity or even entanglement with the nerve. Relative contraindications to arthroscopic treatment of the stiff elbow are determined by the degree of anatomic distortion and the arthroscopic skill and experience of the surgeon.

PREOPERATIVE PLANNING

A thorough appreciation of the pathogenesis of the contracture and the altered anatomy of the contracted elbow is essential. Radiographic assessment with anteroposterior and lateral radiographs is mandatory. Computer tomographic imaging can provide informative detail of the articular surface anatomy and confirm fracture union in posttraumatic cases.

The ulnar nerve deserves particular consideration given its vulnerability and its propensity for tardy neuropathy after contracture release. Preoperative ulnar nerve symptoms must be appreciated, and when present, concurrent ulnar nerve transposition should be planned to accompany the arthroscopic procedure. Transposition generally should also be considered for: 1) releases of contractures that limit flexion to less than 90 degrees and 2) radiographic evidence of a narrowed cubital tunnel secondary to ectopic bone.

ANATOMIC CONSIDERATIONS

Capsular contracture may limit joint capacity to as little as 6 mL, making arthroscopic assessment of the stiff elbow not only more arduous, but more treacherous as well, because neurovascular structures around the elbow will not be as readily displaced as in a normally insufflated and compliant joint. We have found that pressurized insufflation with the use of an 18-gauge needle placed with the tip against bone in the olecranon fossa is often sufficient to break free posterior capsular adhesions and can be a useful technique in facilitating joint distention.

Previous ulnar nerve transposition anteriorly may require open exploration to assure safe medial portal placement. Conversely, an adherent medial capsule or extensive olecranon deformity can displace the ulnar nerve posteriorly, putting it at risk during posterior central portal placement. Care should be taken to direct the cannula into the fossa and avoid medial displacement. Establishing portals in the contracted elbow requires fastidious placement of cannulas, not only when entering through the skin, but also during penetration into the joint to prevent misdirection secondary to hypertrophic or scarred tissue.

The surgeon must continue to remain cognizant of the position of the ulnar nerve throughout the arthroscopic procedure. Any use of a motorized shaver within proximity to the nerve in the medial gutter should be accomplished with a hooded, nonendcutting shaver. Shavers should be directed away from nerves at all times and suction should be turned off.

We use several techniques to protect the posterior interosseous nerve (Fig. 1). The posterior interosseous nerve terminally branches from the radial nerve between the brachioradialis and brachialis muscles. It continues to course just lateral to the brachialis muscle toward the distal half of the elbow where it is immediately adjacent to the anterior joint capsule and radial head. We enter the lateral joint, therefore, through a proximal anterolateral portal, which is significantly further from the radial nerve than the anterosuperior or anterolateral portals (Fig. 2A, B). An inside-out technique minimizes risk of nerve injury. We also elect to remain proximal to the

---

**FIG. 1.** A direct approach to the posterior interosseous nerve for decompression (Lister’s approach) splits the brachioradialis.
radiocapitellar joint when performing a lateral capsulectomy, thereby, maintaining a buffer zone of brachialis muscle between the anterior neurovascular structures and arthroscopic cutting instruments. Working from a medial to lateral direction across the brachialis will assist with localization of the nerve. The use of arthroscopic punches and baskets for debridement may be preferred over motorized instruments in these circumstances. Arthroscopic identification and, if necessary, exploration of the nerve can be undertaken to assure safe release.

### OPERATIVE SETUP

The patient is placed in the prone position per our routine elbow arthroscopic setup. Elbow motion is assessed with an examination under anesthesia. The operative arm is elevated on a 4-inch padded block with the elbow flexed over an arm board at the patient’s side parallel to the table. This method prevents compression of neurovascular structures in the axilla and facilitates medial or lateral access for any contemplated open procedure by means of internal or external rotation of the forearm onto the arm board. A nonsterile pneumatic tourniquet is applied to the arm and inflated to 250 mm Hg after exsanguinating the limb. The arm is sterilized and draped. The forearm and hand are wrapped with a compressive material to restrict fluid extravasation.

A 4.0 mm 30 degree arthroscope and a 3.5 mm full-radius arthroscopic shaver are used. Graspers with teeth and smooth outer surfaces are preferred to prevent hang-up on soft tissue when removing loose bodies. Basket forceps are useful for capsular excision. We find arthroscopic retractors not only practical in protecting nerves from instrumentation, but they can also greatly facilitate visualization, thereby eliminating the need for high pressure joint distension. We strictly limit inflow pressurization to gravity for all elbow arthroscopy procedures.

### SURGICAL TECHNIQUE FOR ARTHROFIBROSIS

The surgical sequence for arthroscopic management of the arthofibrotic elbow is summarized in Table 1. Any planned open concurrent nerve exploration or transposition is completed first. Penrose drains can be used to mobilize and protect nerves during the arthroscopic portion of the case. Insufflation of the elbow is attempted through a direct lateral portal or through a direct posterior portal with the technique previously described. Because the medial epicondyle and medial intramuscular

<table>
<thead>
<tr>
<th>TABLE 1. Surgical Sequence for Arthroscopic Management of the Arthrofibrotic Elbow²⁹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Diagnostic arthroscopy of the anterior compartment</td>
</tr>
<tr>
<td>2. Anterior debridement</td>
</tr>
<tr>
<td>a. Loose body removal</td>
</tr>
<tr>
<td>b. Coronoid spur resection</td>
</tr>
<tr>
<td>c. Radiocapitellar debridement</td>
</tr>
<tr>
<td>3. Anterior capsular release with excision</td>
</tr>
<tr>
<td>a. Medial to lateral resection</td>
</tr>
<tr>
<td>b. Expose brachialis</td>
</tr>
<tr>
<td>4. Diagnostic arthroscopy of the posterior compartment</td>
</tr>
<tr>
<td>5. Posterior debridement</td>
</tr>
<tr>
<td>a. Loose body removal</td>
</tr>
<tr>
<td>b. Olecranon fossa debridement</td>
</tr>
<tr>
<td>c. Elevate triceps with capsular release as necessary</td>
</tr>
<tr>
<td>d. Olecranon spur resection</td>
</tr>
<tr>
<td>6. Medial gutter debridement</td>
</tr>
<tr>
<td>7. Lateral gutter debridement</td>
</tr>
<tr>
<td>8. Olecranon fossa fenestration</td>
</tr>
</tbody>
</table>

Techniques in Orthopaedics®, Vol. 21, No. 4, 2006
septum are preserved in most cases, we prefer to use these landmarks to establish our initial entrance into the joint through a proximal medial portal. A scalpel incision is made through skin only, and penetration through capsule is attempted with a blunt trochar, although a sharp trochar may occasionally be necessary. The arthroscope is introduced through this cannula, and the anterior compartment of the elbow joint is evaluated.

A proximal lateral portal is established with an outside-in technique when possible, or an inside-out technique with a Wissinger rod when necessary. In extremely scarred conditions, access into the joint from the lateral side may not be possible without careful debridement first from the extracapsular side to create a path for portal placement. This technique is quite demanding, however, and a small lateral incision with dissection down to capsule may be preferred. Once intra-articular access has been obtained from the lateral side, the debridement should continue with removal of adhesions from the radiocapitellar joint, facilitated by pronosupination of the forearm.

The anterior capsule is stripped off the humerus proximally to provide additional capsular mobility, and to afford increased working room to visualize and perform an adequate capsular release. An anterior capsulotomy then begins near the coronoid fossa and continues laterally until reaching the lateral intermuscular septum (Fig. 3A). We protect the brachialis muscle by sliding the basket forceps through a plane between brachialis muscle and capsule before excising the capsule in a step-wise manner. The arthroscope is switched to the lateral side, and the capsulotomy is continued from the previous

![Images](A,B,C)

**FIG. 3.** (A) As the release begins, the brachialis fibers begin to be seen through the capsule. (B) The humerus, brachialis, and capsule must be well visualized. (C) After completion of the release and partial excision of the superior aspect of the capsule, the brachialis muscle should be well visualized from medial to lateral across the anterior aspect of the elbow.

![Images](A,B,C)

**FIG. 4.** (A) A degenerative olecranon tip producing posterior impingement. (B) The tip of the olecranon after debridement.
release medially to the medial intermuscular septum, as long as the ulnar nerve remains anatomically located behind this structure (Fig. 3B, C). Care should be taken not to breach the septum.

A capsulectomy is performed with excision of the proximal capsule. A motorized shaver can be used without suction while facing away from the neurovascular structures. Capsular excision should be extended until the anterior structures are no longer tight, but should not exceed more than 2 cm distally. A posterior block to extension should not be misconstrued as an anterior compartment constriction. Once maximum extension through anterior capsular release has been achieved, attention should be turned to the posterior compartment to attain further motion.

A posterior central portal is established with a scalpel skin incision carried deep through triceps muscle and capsule into the olecranon fossa, and a cannula is introduced through this portal with a blunt trochar. The olecranon fossa is often obliterated with scar tissue. Scraping within the fossa with the trochar and pushing the cannula onto bone before removing the trochar are 2 techniques that will assure entry into the joint. Inflow should be maintained through an anterior portal to provide feedback on adequate entry. The arthroscope is introduced and a posterior lateral portal can then be established with a scalpel skin incision carried deep along the lateral edge of the triceps tendon. The olecranon fossa is debrided with a motorized shaver to establish a view (Fig. 4A, B).

The posterior capsule is elevated off the distal humerus with the shaver or a periostial elevator, releasing the adhesions that prevent triceps excursion and elbow flexion, and further increasing the posterior working space (Fig. 5). The medial and lateral gutters are then cleared of scar tissue and adhesions. A retractor portal placed approximately 2 cm proximal to the direct posterior portal will allow for the use of a retractor to improve visualization into the gutters, and to protect the ulnar nerve (Fig. 6). Retraction of the nerve is especially applicable with severe extension contractures, when release of a tight posterior band of the medial collateral ligament is per-

FIG. 5. The triceps muscle is elevated off the distal humerus to facilitate a view of the posterior compartment in this elbow and improve flexion.

FIG. 6. The medial gutter of the elbow is debrided from the postero-central portal while viewing from the posterolateral portal.

FIG. 7. The lateral gutter of the elbow can be debrided while viewing from the postero-central portal using a both the posterolateral and direct lateral portals for instrumentation.
formed. Release should proceed from the olecranon with the nerve retracted toward the medial epicondyle. Excision of lateral gutter adhesions continues from proximally to distally and can be facilitated with debridement of the posterior radiocapitellar recess through a direct lateral portal (Fig. 7). A posterior capsulectomy is performed as required in a sequential fashion, posteriorly, then posterolaterally, and finally posteromedially.

SURGICAL TECHNIQUE FOR ARTHRITIS

The same soft-tissue principles apply when arthritis is accompanied by capsular contractures, but the emphasis in an approach to the stiff arthritic elbow should focus on intrinsic bony pathology. In fact, capsular release is usually unnecessary because the fundamental cause of restricted motion is impingement. A diagnostic arthroscopy routinely begins in the anterior compartment, but attention should be directed to the compartment that requires the most intervention if extended time and fluid extravasations are considerations that may interfere with adequate visualization.

Once arthritic debris, loose bodies and synovitis are cleared from the anterior compartment of the elbow, the coronoid can be evaluated. Coronoid osteophytes are removed and the tip excised (Fig. 8A, B). Ectopic bone within the coronoid fossa is also removed. The radiocapitellar joint is then evaluated. The radial fossa is cleared of any excess bone resulting in impingement. Radial head excision should be considered in cases of severe impingement, degenerative disease or articular incongruity (Fig. 9A). It should not be performed in the

FIG. 8. (A) The coronoid may be deformed in arthritic conditions resulting in impingement as seen in this arthroscopic image. (B) Excision of the coronoid tip and associated osteophytes can restore flexion.

FIG. 9. (A) Arthroscopic examination of this radial head confirmed advanced degeneration seen on preoperative radiographs. (B) The radial head was excised arthroscopically. (C) With proximal radioulnar joint involvement, the entire head can be excised to the level of the radial neck.
Several techniques allow arthroscopic radial head excision to be safely performed. Resection of bone begins with excision of the anterior rim of the radial head from a proximal lateral portal (Fig. 9B). We use a hooded motorized burr directed away from the adjacent anterior capsule at all times. The burr is removed to allow a retractor to be positioned as a backstop behind the anterolateral capsule for further protection of the posterior interosseous nerve. A spinal needle is then used to localize portal placement of the direct lateral portal in the soft spot between the radial head and the capitellum. The burr is then reintroduced through this portal to complete the radial head excision. We remove the proximal 8 to 10 mm of bone in cases of radiocapitellar impingement, incorporating a coplaning technique similar to an arthroscopic acromioplasty (Fig. 9C). Visualization is maintained from the proximal medial portal throughout. The extent of radial head excision may be further evaluated by fluoroscopy, with the proximal radioulnar joint assessed to determine the need for complete removal of the radial head.

Within the posterior compartment, osteophyte excision begins within the olecranon fossa and along its rim, which is recontoured so that no impingement against the olecranon occurs with the elbow in extension. The tip of the olecranon will be addressed next, and the sides of the olecranon should not be overlooked, as osteophytes will commonly be encountered along the medial edge. Overzealous removal of normal bone from this area, however, has been shown biomechanically to increase strain on the medial collateral ligament in cadaver models,\(^9\) which may be of particular concern for throwing athletes.

A transhumeral fenestration modified from the Outerbridge-Kashiwagi procedure\(^10\) (also referred to as an ulnohumeral arthroplasty) can be contemplated as another method to improve excursion of the coronoid and olecranon with good results.\(^{19,26,34}\) We approach this strategy with an arthroscopic modification as it was originally described by the senior author (F.H.S.).\(^{30}\) From the posterocentral portal, a 5 mm pilot hole is drilled through the floor of the olecranon fossa, exiting anteriorly into the coronoid fossa. The drill should be oriented in a slightly proximal direction to accommodate for the articular anatomy. The inflow cannula is maintained anteriorly to irrigate debris retrograde into the posterior compartment. A burr is then used to enlarge the fenestration to a diameter of approximately 2 cm, using the medial and lateral columns of the distal humerus as endpoints (Fig. 10). A pathologically thick fossa membrane will be appreciated in many arthritic cases.\(^{33}\)

**POSTOPERATIVE MANAGEMENT**

There is no universally accepted postoperative regimen for treating the patient with an arthrofibrotic elbow. We prefer to initiate continuous passive motion in the recovery room set at the maximum operative motion achieved, and continue its use for 3 weeks. An aggressive stretching and strengthening program beginning on the day of surgery coincides with this passive program, continuing daily for 3 weeks, and 3 times per week thereafter. Adjustable static splinting may be used after 3 weeks. If significant postoperative motion loss occurs, gentle manipulation under anesthesia to break up the early accumulation of adhesions can be considered within the first 3 weeks. This subset of patients may be at increased risk for ulnar nerve dysfunction, however, if the nerve has not been previously decompressed or translocated.\(^1\)

Our postoperative treatment for patients with arthritic elbows also includes the use of continuous passive motion when capsular releases have been performed. Physical therapy is initiated on the first postoperative day, and the patient is encouraged to resume activities as tolerated. Indomethacin is routinely administered postoperatively for the prevention of heterotopic ossification in all stiff elbow conditions.
RESULTS

The early application of elbow arthroscopy for treatment of the stiff elbow was limited to those patients with less severe contractures,32 or to those requiring minimal osteophytic release to improve motion.8,23 With advances in technique, however, arthroscopic management has supplanted open management of the stiff elbow as the operative treatment of choice in many cases. Much more extensive processes are currently treated arthroscopically, with outcomes and complication rates comparable to open releases.2,3,12,15,21,22,24,28,30 Not surprisingly, arthroscopic treatment of the arthritic elbow appears to provide less relative benefit as the disease process progresses Table 2.15 lists the results that are currently being reported in the literature (Table 2). These techniques are becoming increasingly attractive for the treatment of the pediatric patient,16 although, historically, the results of arthroscopic capsular release in pediatric patients have been less favorable and predictable than those in adult patients.31

COMPLICATIONS

Nerve injuries remain at the forefront of concern in the reported complications of elbow arthroscopy. In a Mayo Clinic retrospective review of 473 elbow arthroscopies,11 capsular release was one of the two factors associated with a higher risk of nerve palsy, with a diagnosis of rheumatoid arthritis being the other. In the treatment of elbow contractures by arthroscopic capsular release, Kim et al.12 have reported two transient median nerve palsies, Jones and Savoie8 have reported a transection of the posterior interosseous nerve, and Haapaniemi et al.7 have reported a transection of the median and radial nerves. Clearly, anterior and posterior capsulectomies are technically demanding procedures that should be performed only with extreme caution by surgeons with substantial experience in arthroscopy of the elbow.

OVERVIEW

When performed in properly selected patients, both arthroscopic and open treatment of elbow stiffness can have satisfactory results. Arthroscopic management of the stiff elbow, however, offers substantial advantages over open procedures. Limited skin incisions and soft tissue dissection not only decrease the risk of scarring, but also allow the patient to safely undertake an immediate aggressive postoperative physical therapy program. These measures can reduce the recurrence of contracture in a joint well recognized for its propensity for stiffness. Arthroscopy allows the surgeon to address extrinsic capsular and collateral ligament contractures, as well as intrinsic joint pathology, with increased visualization, and, with, therefore, a more comprehensive appreciation of the pathology. Concomitant procedures, such as radial head excision, when indicated, can also be performed arthroscopically. Recognition of the proximity of the neurovascular structures is critical to minimizing complications, but expertise in elbow arthroscopy and meticulous surgical technique can produce excellent results.

REFERENCES


<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>No</th>
<th>Preop ROM</th>
<th>Postop ROM</th>
<th>Improvement Degree</th>
<th>Satisf %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phillips and Strasburger</td>
<td>1998</td>
<td>15</td>
<td>40–90</td>
<td>8–139</td>
<td>(49%)</td>
<td>41</td>
</tr>
<tr>
<td>Savoie et al.</td>
<td>1999</td>
<td>24</td>
<td>35–117</td>
<td>7–140</td>
<td>42</td>
<td>100</td>
</tr>
<tr>
<td>Potzl et al.</td>
<td>2000</td>
<td>36</td>
<td>79 arc</td>
<td>121 arc</td>
<td>52</td>
<td>92</td>
</tr>
<tr>
<td>Kim and Shin</td>
<td>2000</td>
<td>63</td>
<td>38–112</td>
<td>5–133</td>
<td>54</td>
<td>94</td>
</tr>
<tr>
<td>Ball et al.</td>
<td>2002</td>
<td>14</td>
<td>40–100</td>
<td>7–140</td>
<td>73</td>
<td>94</td>
</tr>
<tr>
<td>Krishnan</td>
<td>2005</td>
<td>11</td>
<td>38–112</td>
<td>5–133</td>
<td>54</td>
<td>94</td>
</tr>
<tr>
<td>McLaughlin et al.</td>
<td>2006</td>
<td>36</td>
<td>38–112</td>
<td>5–133</td>
<td>54</td>
<td>94</td>
</tr>
</tbody>
</table>

Techniques in Orthopaedics9, Vol. 21, No. 4, 2006


