Surgical Release for Posttraumatic Loss of Elbow Flexion

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Introduction

We describe a surgical release for patients who have a lack of elbow flexion limiting the ability to perform activities of daily living after trauma.

Joint stiffness is a well-recognized complication following trauma to the elbow. It is generally agreed that an arc of elbow flexion from 30° to 130° is required for the performance of most activities of daily living¹. Patients who have stiffness following elbow injury usually experience limitations in both flexion and extension. In contrast to flexion contractures²⁻⁴, the primary cause of elbow flexion loss and the best surgical approach for achieving maximum flexion has not been well investigated^{5,6}.

A variety of elbow injuries, such as intra-articular and extra-articular fractures, dislocations with and without fractures, and even local injuries without fracture, can cause stiffness despite proper initial treatment, including surgery. The indication for surgical release to treat a lack of elbow flexion is a persistent loss of elbow motion that limits the ability to perform activities of daily living for at least six months after the injury despite nonoperative treatment. Although the arc of motion required for normal function differs among patients, depending on the tasks, age, and activities, <100° of flexion usually requires operative treatment.

Prior to surgical release, elbow stability must be confirmed by a careful physical examination. Healing of fractures should be evaluated on radiographs. Computed tomography (CT) is sometimes helpful in assessing articular congruity and the presence of heterotopic bone around the elbow.

We found that, to achieve maximum flexion, the posterior capsular release should be extended to the posteromedial aspect of the capsule, which coincides with the posterior band of the medial collateral ligament. On the basis of the functional anatomy of the medial collateral ligament, the posterior band lies posterior to the axis of flexion and thus varies greatly in length during ulnohumeral motion, while the length

of the anterior band remains relatively unchanged⁷. A great increase in the length of the posterior band during flexion explains why contracture of the posterior band contributes to limitation of full flexion (Figs. 1-A and 1-B). Several authors have pointed out the role of posterior band contracture in restricting elbow flexion^{5,6}.

Heterotopic ossification is a well-known cause of elbow stiffness following trauma, although its pathogenesis is poorly understood. We found that heterotopic ossification, particularly in the posterior aspect (involving the posteromedial aspect of the capsule), is highly associated with posttraumatic loss of flexion. CT, in addition to radiographs, is recommended to evaluate the presence and location of heterotopic bone. In our experience, the heterotopic bone has been occasionally unclear on radiographs. Rather than relying on radiographic detection, one can suspect the presence of heterotopic ossification clinically, as it presents initially as local soft-tissue swelling, tenderness, warmth, and progressive loss of elbow motion. As the heterotopic ossification matures, the inflammatory condition resolves but motion remains limited. Preoperative studies to detect small foci of heterotopic ossification are not critical as long as the posteromedial aspect of the capsule is fully addressed during surgical release. For prophylaxis against recurrence of heterotopic ossification, we recommend a single 700-cGy dose of radiation within forty-eight hours after the surgical release.

One should recall that the ulnar nerve has a high likelihood of entrapment within the cubital tunnel associated with pathological changes of the posteromedial aspect of the capsule. Although preoperative electrophysiological studies and occasionally magnetic resonance imaging (MRI) are helpful for assessing the preoperative status of the ulnar nerve, the necessity of anterior transposition of the ulnar nerve should be determined intraoperatively on the basis of the findings at the time of surgery (see Clinical Comments). Our experience indicates that the majority of patients require transposition.

We present the technique for surgical release of a stiff elbow due to extrinsic causes, particularly for patients with substantial loss of elbow flexion. To achieve a maximum arc of motion with use of extra-articular procedures, the following structures or lesions should be evaluated during the surgical procedure:

1. Ulnar nerve
2. Posterior aspect of the capsule and posterior band of the medial collateral ligament
3. Heterotopic ossification
4. Anterior aspect of the capsule
5. Triceps muscle and tendon

The procedure is done in seven stages:

Step 1: Mobilize the ulnar nerve

Step 2: Dissect the triceps and resect the posterior aspect of the capsule

Step 3: Resect the posterior band of the medial collateral ligament

Step 4: Resect the anterior aspect of the capsule

Step 5: Lengthen the triceps if indicated

Step 6: Transpose the ulnar nerve anteriorly

Step 7: Postoperative management

Step 1: Mobilize the Ulnar Nerve

Mobilize the ulnar nerve through the cubital tunnel with the accompanying superior ulnar collateral vessels.

- Place the patient in a supine position and apply a pneumatic tourniquet around the upper arm.
- Determine the skin incision, considering several factors including the location of the previous incision, the site of heterotopic bone, and whether there are radial head adhesions. Use a posterior incision if a lateral approach is planned to release the radial head. Otherwise, make a 15-cm longitudinal incision, centered at the medial humeral epicondyle, along the lateral border of the triceps and distally passing between the medial epicondyle and the olecranon.
- Identify the ulnar nerve proximally and place a vessel-loop around it. Mobilize the ulnar nerve distally through the cubital tunnel with the accompanying superior ulnar collateral vessels (Fig. 2).
- Release the Osborne ligament and the fascia covering the nerve, and transpose the ulnar nerve anteriorly over the medial epicondyle.

Step 2: Dissect the Triceps and Resect the Posterior Aspect of the Capsule

Dissect the triceps from the distal part of the humerus and resect the posterior aspect of the capsule to expose the olecranon tip and fossa.

- Identify the plane between the triceps muscle/tendon and the periosteum of the posterior humeral surface from the medial border. Dissect the triceps from the distal part of the humerus and posterior aspect of the capsule over the olecranon fossa. Resect the entire posterior aspect of the capsule using a blade and rongeur to expose the olecranon tip and olecranon fossa (Fig. 3).
- Excise heterotopic bone if it is present in the posterior aspect of the distal part of the humerus around the olecranon.
- Check the passive flexion arc at this stage, keeping in mind that the elbow invariably fails to regain full range of flexion at this stage.

Step 3: Resect the Posterior Band of the Medial Collateral Ligament

Release the posterior band of the medial collateral ligament while continually checking the flexion arc until >130° of flexion can be achieved.

- Extend the release to the posteromedial aspect of the capsule between the medial side of the olecranon and the trochlea, which coincides with the posterior band of the medial collateral ligament.
- Start the resection of the posterior band of the medial collateral ligament posteriorly and carefully advance it anteriorly while continually checking the flexion arc until >130° of flexion can be achieved. Be careful not to violate the anterior band of the medial collateral ligament, which is the main stabilizer of the elbow with valgus stress (Fig. 4).
- If heterotopic bone is embedded in the posterior band, excise it together with the fibrous capsule. Do not attempt to remove heterotopic bone located in the anterior band because it usually does not limit full flexion. Full passive flexion is usually possible at this stage.

Step 4: Resect the Anterior Aspect of the Capsule

Perform an anterior approach if there is persistent flexion contracture or any impingement restricting full flexion.

- After the posterior release is completed, perform an anterior approach if there is a persistent flexion contracture of $>10^{\circ}$ or any impingement restricting full flexion such as heterotopic bone.
- Elevate the brachialis muscle and the superior portion of the flexor-pronator muscles from the medial supracondylar ridge and the anterior surface of the distal part of the humerus. Develop the plane between the brachialis and the anterior aspect of the capsule. Resect the anterior aspect of the capsule using a scalpel (Fig. 5).
- Be careful not to injure the deep radial nerve when the lateral side of the capsule is excised. Release, rather than resect, the lateral portion of the anterior aspect of the capsule after separating the capsule from the overlying muscles.

Step 5: Lengthen the Triceps If Indicated

Consider triceps lengthening if you cannot achieve $>130^{\circ}$ of passive flexion with two fingers.

- If full flexion is not regained after Step 4, address other pathologic lesions restricting the full arc of motion. The most common lesion is contracture of the triceps secondary to long-standing loss of flexion.
- Consider triceps lengthening if, at this stage, $>130^{\circ}$ of passive flexion cannot be achieved when you apply a force with two fingers. Make a V-shaped incision on the surface of the aponeurosis and check the passive arc of flexion. If the release is still insufficient, perform V-Y-type lengthening with appropriate muscle tension.

Step 6: Transpose the Ulnar Nerve Anteriorly

Locate the released ulnar nerve over the medial humeral epicondyle on the fascia overlying the common flexor-pronator muscles.

- Before closure, assess elbow stability to ensure that range-of-motion exercises can be started immediately postoperatively.
- Repair the common flexor-pronator muscles that were detached during Step 4.
- Excise the medial intermuscular septum, and locate the released ulnar nerve over the medial humeral epicondyle on the fascia overlying the common flexor-pronator muscles (Fig. 6). Release the pneumatic tourniquet and obtain careful hemostasis.

- Use three stitches between the subcutaneous tissue and the edge of the medial epicondyle to make a dermofascial sling over the ulnar nerve to prevent posterior relocation. Close the wound over a suction drain.

Step 7: Postoperative Management

Physical therapy consists of active-assisted and gentle passive flexion and extension exercises of the elbow, usually for two to six months.

- Apply a long arm splint following surgery. For patients with marked loss of flexion, a splint in the flexed position is preferred as long as circulation of the skin flap is not compromised.
- Physical therapy is started two to four days postoperatively, after the pain and swelling have become tolerable. This therapy consists of active-assisted and gentle passive flexion and extension exercises of the elbow. Continuous passive motion is helpful for the initial three to five days so the patients can gain rapid confidence with motion exercises.
- Continue physical therapy until elbow motion reaches a plateau, which means that active maximum motion is possible without additional effort and persists without continuing physical therapy. The duration of physical therapy usually ranges from two to six months.

Results

Forty-two patients with $<100^{\circ}$ of elbow flexion as an extrinsic contracture following trauma had a surgical release of the elbow at a median of ten months post-injury. Mean flexion increased significantly from 89° preoperatively to 124° (range, 90° to 140°) at a mean of thirty-nine months after the operation. The mean flexion contracture decreased from 34° preoperatively to 9° (range, 0° to 30°) after the operation. Overall, $\geq 120^{\circ}$ of final flexion and $\geq 100^{\circ}$ of the functional arc were regained by 88% of the patients. The mean Mayo Elbow Performance Index score improved significantly from 73 points to 94 points (range, 72 to 100 points), with the result rated as excellent for thirty-two patients, good for eight, and fair for two. Two patients had clinical recurrence of heterotopic ossification associated with a failure to increase flexion.

What to Watch For

Indications

- Patients who have substantial loss of flexion as an extrinsic contracture following trauma despite physical therapy. They must have a

stable joint, and initial injuries should be healed clinically and radiographically.

- Patients with intra-articular injuries can be treated with this procedure if healing does not affect ulnohumeral motion, as indicated by radiographic or CT findings of a congruent articular surface and an intact joint space.
- When radiographs and symptoms suggest heterotopic ossification, surgical release should be delayed until symptoms such as pain, swelling, and tenderness subside and heterotopic bone appears mature on radiographs.

Contraindications

- An incongruent joint or loss of articular surface to a degree sufficient to affect joint motion. Arthroplasty such as interposition or total elbow replacement should be considered in such cases.
- Patients who only require release of a flexion contracture. A lateral column procedure or arthroscopic release is recommended for those patients.

Pitfalls & Challenges

- Release of the posterior band should be advanced millimeter by millimeter while you check the passive flexion arc until full flexion is restored. There is a risk of rupture of the anterior band if forced passive flexion is attempted to gain full flexion in patients with marked flexion loss. If the anterior band ruptures, it should be repaired; this is followed by application of a hinged brace during later motion exercises.
- A medial approach is not always enough to achieve a maximum arc of elbow motion. Additional release of the anterior and posterior as-

pects of the capsule through a lateral approach may be needed if a sufficient arc of motion is not regained.

- The implants that were applied for fracture fixation can be removed only when the union of the initial fracture is sufficient to allow immediate physical therapy. They should be removed at the last step of the procedure once the maximum arc of motion is achieved by surgical release.

Clinical Comments

- What are the indications for ulnar nerve transposition? It must be remembered that subclinical neuropathy may be present under conditions of marked limitation of flexion⁸. Delayed-onset ulnar nerve symptoms can result from stretching and compression of the ulnar nerve in the cubital tunnel with rapid recovery of terminal flexion postoperatively, which will inhibit physical therapy. Because of the risk of secondary entrapment, we strongly recommend transposition of the ulnar nerve when a poor bed for the ulnar nerve remains after radical excision of the posteromedial aspect of the capsule.
- Recurrence or development of heterotopic ossification is the main reason for failure to achieve maximum flexion. However, there appears to be no reliable method to prevent heterotopic ossification following elbow trauma or surgery. The use of low-dose radiation has been widely recommended^{9,10}, but its efficacy in preventing recurrence remains unclear.

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Figures

Figs. 1-A and 1-B Schematic drawings showing the change in length of the posterior band of the medial collateral ligament during ulnohumeral motion. A great increase in the length of the posterior band during flexion explains why the contracture of the posterior band contributes to limitation of full flexion.

Fig. 2 The ulnar nerve is identified proximally and is released distally through the cubital tunnel with preservation of accompanying vessels.

Fig. 3 After the triceps muscle is dissected from the distal part of the humerus, the posterior aspect of the capsule is excised enough to expose the olecranon tip and fossa.

Fig. 4 As a critical step of the release, the posterior band of the medial collateral ligament should be removed (dashed line). Start posteriorly and carefully advance anteriorly, taking care not to violate the anterior band of the medial collateral ligament.

Fig. 5 An anterior approach is required if there is persistent flexion contracture or any impingement restricting full flexion. The brachialis and the superior portion of the flexor-pronator muscles are elevated and the anterior aspect of the capsule is excised carefully so as not to injure the deep radial nerve.

Fig. 6 After repair of the proximal origin of the flexor-pronator muscles, the released ulnar nerve is transposed over the medial epicondyle and placed on the fascia overlying the flexor-pronator muscles.

Fig. 1-A

Fig. 1-B

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6