Ulnar Collateral Ligament Reconstruction in Posttraumatic Elbow Release

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abstract

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The purpose of this retrospective cohort comparison study was to determine the effect of ulnar collateral ligament reconstruction on postoperative range of motion (ROM) in patients undergoing posttraumatic elbow contracture release.

Twenty-four consecutive patients underwent elbow arthrolysis. Six patients also underwent simultaneous collateral ligament excision and reconstruction, and 18 did not require ligament excision. All patients followed the same postoperative rehabilitation program. Minimum follow-up was 12 months. Final flexion/extension ROMs were similar in both groups. No subjective reports of postoperative elbow instability occurred in either group.

Ligament reconstruction and early postoperative motion can be safely performed in the setting of posttraumatic elbow capsulectomy without sacrificing ROM gain or compromising stability provided by the ligament reconstruction.

Figure: Radiograph demonstrates abundant ossification involving the ulnar collateral ligament.
Stiffness following traumatic elbow injuries is a common occurrence. The periarticular soft tissues have potential to contribute to the degree of stiffness. The medial and lateral collateral ligament complexes are often injured in elbow fractures or dislocations and have a propensity toward calcification and contracture. In addition, the brachialis muscle belly lies directly adjacent to the anterior capsule and is highly vascular and prone to bleeding.

Hematoma formation has been implicated in the formation of heterotopic ossification. Heterotopic ossification can result from various local or systemic processes, including head injury, burns, and genetic disorders, but direct trauma is the most frequent cause. A correlation exists between the severity of injury and the prevalence of heterotopic ossification. The combination of ligamentous calcification and heterotopic ossification formation can result in severe functional limitations in elbow range of motion (ROM) and function.

Most of the literature on the treatment of postrumatic stiff elbow comprises reports of various surgical capsulectomy techniques. The senior author (D.P.H.) previously published his results of early “simple” release through a posterior approach. This global release and intensive postoperative therapy produced end results similar to others in the literature. Using this technique, attempts are made to preserve the collateral ligaments. However, if the ligaments are calcified and act to limit the overall ROM, they are excised.

Reports of instability after elbow fractures are rare, no reports exist of instability after treatment of postrumatic stiff elbow. Ring and Jupiter reported that hinged external fixation can be used if this situation arises, but that isolated ulnar collateral or lateral ulnar collateral ligament incompetence typically does not merit external fixation and that instability does not become an issue for patients postoperatively following ligament excision.

In the senior author’s study, one patient had varus and valgus instability and was treated with a hinged external fixator. Two patients treated subsequent to that article went on to experience clinical valgus instability of the elbow after excision of the calcified and contracted ulnar collateral ligaments as part of the capsulectomy. These complications prompted the change in treatment protocol that is investigated in the current study, so that ligament reconstruction is performed if instability is produced by the soft tissue release and heterotopic ossification resection.

The application of a hinged external fixator for elbow instability can be a challenging procedure. A recent study concluded that the use of a hinged external fixator can effectively stabilize the ligamentous unstable elbow but at the expense of changes in the normal ROM pattern, encouraging varus malalignment and a loss of extension. The standard of care at our institution has been to avoid the use of hinged external fixation devices following elbow contracture release and to perform simultaneous collateral ligament reconstruction to restore elbow stability and then engage the patients in an early ROM program. The purpose of this study was to review our experience with patients treated with this treatment protocol. We hypothesized that ligament reconstruction would not compromise the overall result of the elbow release procedure in terms of ROM gained when compared with patients who did not require ligament reconstruction to restore elbow instability.

### MATERIALS AND METHODS

#### Patient Selection and Demographics

This study was approved by our institution’s Human Investigation Committee. We retrospectively reviewed the charts of all patients who had undergone an elbow release procedure without the use of an external fixator for postrumatic stiff elbow between 2000 and 2005. Data collected included age, sex, date and type of initial injury, number of previous surgeries prior to the release procedure, pre- and postoperative ROM, and the need for any secondary surgeries. A total of 96 procedures were performed during this time period. We hypothesized that any follow-up period <12 months would be incomplete and thus excluded all patients who fell into this category.

The remaining 24 patients fell into 2 subgroups: 18 had a simple elbow release (group 1) and 6 had allograft ulnar collateral ligament reconstruction in addition to a simple elbow release (group 2). Demographics for the 2 groups were similar (Table 1). The patients in group 2 tended to have worse contractures that required earlier contracture release, but these differences did not reach statistical significance.

#### Indications

Our criteria for elbow contracture release included: (1) function-limiting elbow stiffness resulting from musculoskel-
et al trauma (limitation was defined as subjective complaints regarding the activities of daily living and at least 1 of 2 objective findings; a flexion/extension ROM <100° or a flexion contracture >45°); (2) radiographic evidence of union of fractures; (3) radiographic evidence of intact ulnohumeral joint articular surfaces; (4) heterotopic ossification in any stage of maturity on plain radiographs; and (5) stabilization of traumatic brain injury when associated with heterotopic ossification. Contractures following thermal injury were excluded.3

SURGICAL TECHNIQUE

All patients underwent a global release of all soft tissue contractures as previously described. The patient was placed supine on the operating table with the operative arm abducted on the hand table. A tourniquet was not used. The entire arm was prepped to the axilla. Attempts were made to incorporate previous scars into the surgical incision. Prior to making the incision, the subcutaneous tissue in line with the planned incision was infiltrated with 0.25% bupivacaine with epinephrine to aid with superficial hemostasis.

A posterior incision was made extending from the mid-humerus, running lateral to the olecranon, and extending distally along the subcutaneous border of the ulna. Full-thickness fasciocutaneous flaps were made down to the level of the triceps. Attention was directed to the ulnar nerve first. If the nerve had been transposed previously, it was identified and protected. If the patient had ulnar nerve symptoms despite a previous subcutaneous transposition, a complete neurolysis was performed in addition to an anterior submuscular transposition. Neurolysis and anterior submuscular transposition were performed during the release procedure if they were not performed previously. The actual transposition component of the procedure was performed after the elbow release and immediately prior to wound closure.

Posteriorly, a tenolysis of the triceps was performed, and the posterior capsule was excised from the olecranon fossa from a deep approach along the medial border of the triceps. All heterotopic ossification and fibrous tissue were debrided from the olecranon fossa using curettes, rongeurs, and high-speed burrs. Olecranon tip ostearthroplasty was performed with osteotomes. After the posterior anatomy of the distal humerus and proximal ulna had been restored, attention was directed anteriorly through the same posterior incision by elevating a medial flap. The bicapital aponeurosis was divided, and a tenolysis of the brachialis was performed. The interval between the brachialis and the pronator teres was developed. The median nerve and brachial artery were identified anteriorly, and the common flexor tendon origin was elevated from the medial epicondyle in a step-cut fashion. All attempts were made to preserve the anterior band of the ulnar collateral ligament. The anterior capsule of the elbow joint was excised completely, and heterotopic ossification from the coronoid fossa was removed in a similar fashion to the olecranon fossa. In addition, any osteophytes from the tip of the coronoid were removed.

In 6 patients (group 2), the ulnar collateral ligament was encased in heterotopic bone, and preservation of this structure would have resulted in an incomplete release (Figure 1). In this setting, the ligament was resected to achieve a greater ROM. We have found that ulnar collateral ligament release in the setting of a wide capsular excision results in significant valgus instability as the elbow is passively extended. To address this iatrogenic valgus instability, the ulnar collateral ligament was subsequently reconstructed using a hamstring allograft using the technique described by Conway et al.18

After the capsule and heterotopic ossification had been removed medially, anteriorly, and posteriorly, the elbow was manipulated and taken through a ROM to ensure that a complete release had been performed. In situations where attention was required to the lateral elbow joint (as in radial head fractures, nonunion, loss of forearm rotation, ossification around the lateral ligament complex, or lateral ligament insufficiency), a lateral approach was made through the same posterior incision.

Once the complete release had been performed and the ROM and stability had been restored to the elbow, any previously placed plates and screws were removed. This was done after any manipulation to avoid creating a fracture through a stress riser. The ulnar nerve was then transposed in a submuscular position. The origin of the flexor–pronator mass was repaired back to the medial epicondyle with nonabsorbable sutures.

The wound was copiously irrigated with 3 L of saline solution and then closed over a drain. The arm was placed into a soft compressive dressing that would not interfere with elbow ROM.

Postoperative Care

An infraclavicular block and indwell catheter were placed for postoperative pain control, and the patient was placed into a continuous passive motion machine on arrival to the postanesthesia care unit. The occupational therapist fabricated a
custom thermoplastic resting splint that held the upper extremity in maximum elbow extension and forearm supination. The patient was kept in the continuous passive motion machine for all awake hours except when working with the therapist for gravity-assisted ROM exercises. The splint was worn at night. No patient was treated with radiation therapy or indomethacin for heterotopic ossification prophylaxis.

Patient Evaluation

Each patient was evaluated at every follow-up visit for ROM, signs of infection, and evidence of elbow instability. All data were collected and analyzed from a retrospective review of the medical records by a trained examiner (K.J.M.) not involved in the patients’ care.

Statistical Analysis

Pre- and postoperative flexion/extension ROMs were compared using a 2-tailed paired Student’s t test. Analysis was performed using Microsoft Excel (Microsoft, Redmond, Washington). Statistical significance was set at $P < .05$.

RESULTS

Results are shown in Figures 2 and 3 and Table 2. Average follow-up was 25.3 months in group 1 (range, 12-55.7 months) and 19.9 months in group 2 (range, 13-54.3 months) ($P > .05$). In group 1, extension improved from 48° to 13° and flexion improved from 103° to 128°, which resulted in an overall ROM improvement from 55° to 115°, or by a magnitude of 2.1. In group 2, extension improved from 52° to 22° and flexion improved from 80° to 122°, which resulted in an overall ROM improvement from 28° to 100°, or by a magnitude of 3.6. No statistically significant difference in postoperative ROM or overall improvement of ROM was observed between the 2 groups.

No intraoperative complications occurred. One patient from each group required a hematoma evacuation during the postoperative hospitalization period. Three patients from group 1 required a subsequent procedure for removal of symptomatic hardware that was not removed during the initial procedure. One patient from group 1 required a subsequent ulnar nerve neurolysis and revision from a subcutaneous transposition done at the initial fracture surgery to an anterior submuscular transposition. One patient required a secondary procedure to take down a forearm synostosis. No postoperative elbow dislocations or subjective reports of elbow instability occurred in either group. Varus and valgus stress testing of all elbows revealed no evidence of instability.

DISCUSSION

The current study represents the first report of simultaneous ligament reconstruction and posttraumatic elbow capsulectomy. Until now, the general consensus has been that instability is not a problem following capsulectomy, even if the ligaments have been excised, and that ligament reconstruction is not necessary. No published reports exist of ligament reconstruction to restore elbow stability after high-energy injuries. The purpose of the current study was to offer the possibility of allograft ligament reconstruction when excision of a calcified ligament results in iatrogenic elbow instability. This scenario is relatively uncommon, and no clear best treatment plan exists.

All allograft ligament reconstruction procedures performed in group 2 were ulnar collateral ligament reconstructions. The reason for the bias toward ulnar collateral ligament as opposed to lateral ulnar...
collateral ligament reconstruction was that the majority of the patients were being treated for contractures in the flexion/extension ROM, the releases were done from a medial approach to the joint, and the lateral collateral ligament complex was spared. Ulnar collateral ligament reconstruction has typically been reserved for symptomatic valgus instability in overhead-throwing athletes. The rehabilitation protocol for ligament reconstruction in the overhead-throwing athlete differs from that following posttraumatic capsulotomy. In the former, the elbow is rested for 7 to 10 days and then protected motion is initiated, often with the aid of a hinged elbow brace. Our standard postoperative protocol following capsulotomy was for immediate and unprotected elbow motion using continuous passive motion and gravity-assisted motion. We also instituted this protocol for the ligament reconstruction patients.

The results of our study suggest that patients who required ligament reconstruction had more severe preoperative contractures and more numerous surgical procedures before the capsulotomy and were released sooner in terms of time from initial injury than patients who did not require ligament reconstruction. Postoperatively, the patients requiring ligament reconstruction made greater gains with regard to ROM than those who were left with intact native ligaments, resulting in overall comparable ROMs between the 2 groups of patients. This is likely the result of having a more limited preoperative ROM. These results compare favorably to previously published reports. In addition, the final ROMs obtained in both groups were within the functional elbow ROM as defined by Vasen et al. These findings have affected the way we treat these patients. Our current practice is to excise the calcified collateral ligaments if their preservation results in inadequate intraoperative ROM and then perform collateral ligament reconstruction with an unaltered postoperative ROM and therapy program.

This study had some limitations. We collected data for just 24 of the 96 patients who underwent elbow capsulotomy during our collection period. This is a result of those lost to follow-up before 12 months, as is common in the patient population treated at a county trauma center. We chose 12 months as our minimum follow-up because we noticed minimal change in ROM after this time point. We realized that having a longer follow-up period as a requirement for inclusion would significantly reduce the number of patients evaluated to the point that making conclusions would be difficult. In addition, the retrospective nature of data collection in this study potentially limits our conclusions. Information from patient visits were abstracted from a review of medical records, and the information could not be tested for accuracy or consistency. We were not able to include assessments of any functional measurement tools, such as the Disabilities of the Arm, Shoulder, and Hand score or the Mayo elbow score, which would have bolstered our results. We did not assess patient subjective pain scores or ability to return to work.

However, we feel that our results allowed us to make the following conclusions: (1) ligament excision and allograft reconstruction is appropriate in the setting where preservation of the calcified and contracted ligament results in a less-than-complete release; (2) performing simultaneous ligament reconstruction and capsulotomy for posttraumatic elbow contractures does not lead to inferior results in terms of ROM when compared with a standard capsulotomy; and (3) engaging patients who undergo a ligament reconstruction procedure as part of their capsulotomy procedure in an early motion program does not compromise the stability provided by the ligament reconstruction.

**REFERENCES**

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