

ORIGINAL ARTICLE

Primary Ligament Repair for Elbow Dislocation

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Abstract: Few have been reported on the role of early primary ligament repair for acute unstable elbow dislocation. The purpose of this study is to evaluate the clinical outcome of early primary ligament repair for unstable elbow dislocation followed by protected early joint mobilization exercise.

Thirteen patients who underwent operative treatment due to unstable elbow dislocation without associated fracture were retrospectively reviewed. There were 11 male and 2 female with average age of 37 years (range; 18-72 years). Surgical indications of the unstable elbow were subluxation or non-congruent elbow joint on the radiographs following closed reduction. Elbow dislocation which required extension block splint over 45 degrees to maintain reduction was considered as unstable elbow dislocation.

In ten patients, full stability was restored only after both medial and lateral structures were re-attached. In two patients, only lateral structure (LCLC and common extensor tendon) was repaired and in one patient, only medial structure (MCL and flexor pronator tendon) was repaired for stability. Overall mean functional Mayo Elbow Performance Score was 93.5 (range; 70-100). No elbow was dislocated or subluxated after operation. All ten patients returned to previous work level in average of 3.5 months. Heterotopic calcification was noted in six patients and three had mild ulnar nerve symptoms after operation.

In conclusion, primary ligament repair in acute unstable elbow dislocation were successful, because surgery achieved sufficient stability to allow early exercise (Keio J Med 57 (2) : 99-104, June 2008)

Key words: Unstable Elbow, Ligament Repair

Introduction

Complex instability of the elbow joint which is defined as an injury that destabilizes the elbow joint because of damage to the articular surface and the ligamentous structures is a challenging problem.¹ This injury comprises around 49% of elbow dislocations and most of these fractures are inherently unstable and require surgery.² Because prolonged elbow immobilization after this complex injury produces poor results, surgery must achieve sufficient stability to allow early range of motion exercise. Thus, the primary goal of the treatment for the complex instability of the elbow joint is to restore the essential elements, the ulnohumeral joint by osteosynthesis

of fractures, and lateral column, radiocapitellar joint and then to repair collateral ligament complex.³ A hinged external fixator is advised in certain circumstances in which it is desirable to protect fractures or ligament repair.^{4,5} Because of contracture after prolonged immobilization or instability after poor healing of fracture or soft tissue damage, early joint mobilization with sufficient surgical stability is crucial for successful outcome.

There have been a few reports on complex elbow dislocations with associated fractures in the literature, which reported acceptable functional outcome with hinged external fixator.^{2,6,7} However, few have been reported on the role of early primary ligament repair for acute unstable elbow dislocation.^{7,8} The purpose of this

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Table 1 Details of the patients with unstable elbow dislocation

| No | Gender | Age | Cause of Injury | Side | Associated injury | Soft tissue | Surgical approach | Operation | Complication | MEPS ⁹ | FU |
|-----|--------|------|-----------------|------|--------------------|----------------|-------------------|---------------------------|-----------------------------|-------------------|----|
| 1 | M | 37 | Fall | L | | MCL/FP+LCLC/CE | M+L | LCLC/CE +MCL/PF repair | Ulnar nerve Sx | 100 | 12 |
| 2 | F | 50 | Fall | L | | MCL/FP+LCLC/CE | M+L | LCLC/CE +MCL/PF repair | | 100 | 36 |
| 3 | M | 46 | RTA | L | ICH | MCL/FP+LCLC/CE | M+L | LCLC/CE +MCL/PF repair | | 100 | 34 |
| 4 | M | 27 | Fall | L | | MCL/FP+LCLC/CE | M+L | LCLC/CE +MCL/PF repair | | 85 | 32 |
| 5 | M | 18 | Judo | R | | MCL/FP | M | MCL/FP repair | HO-M | 100 | 28 |
| 6 | F | 72 | Fall | L | Distal radius fx | LCLC/CE | L | LCLC+CE repair | | 75 | 16 |
| 7 | M | 46 | Fall | R | Brachial a rupture | LCLC/CE | L | LCLC+CE repair | Stiffness HO-M/L | 85 | 18 |
| 8 | M | 43 | Fall | R | Spine fx | MCL/FP+LCLC/CE | M+L | LCLC/CE +MCL/PF repair | HO-M/L Ulnar nerve Sx | 100 | 26 |
| 9 | M | 22 | Triathlon | R | | MCL/FP+LCLC/CE | M+L | LCLC/CE +MCL/PF repair | HO-M | 100 | 28 |
| 10 | M | 23 | Fall | L | | MCL/FP+LCLC/CE | M+L | LCLC/CE +MCL/PF repair | | 100 | 35 |
| 11 | M | 35 | Fall | R | Distal radius fx | MCL/FP+LCLC/CE | M+L | LCLC/CE +MCL/PF repair | Stiffness Ulnar nerve Sx | 70 | 37 |
| 12 | M | 40 | RTA | R | ICH | MCL/FP+LCLC/CE | M+L | LCLC/CE +MCL/PF repair | Massive HO-M/L/A/P | 100 | 32 |
| 13 | M | 21 | Judo | L | Mandicule fx | MCL/FP+LCLC/CE | M+L | LCLC/CE +MCL/PF repair | HO-M | 100 | 18 |
| Ave | 11:2 | 36.9 | | | | | | | | 93.5 | 27 |

(M: male, F: female, RTA: road traffic accident, R: right, L: left, ICH: intra-cranial hemorrhage, MCL:medial collateral ligament, FP: flexor pronator tendon, LCLC: lateral collateral ligament complex, CE: common extensor tendon, M: medial, L: lateral, HO: heterotopic ossification, Ulnar nerve Sx: ulnar nerve symptoms, MEPS: Mayo Elbow Performance Score, FU: follow up)

study is to analyze and report the clinical outcome of early primary ligament repair for unstable elbow dislocation followed by protected early joint mobilization exercise.

Methods

From January 2004 to January 2006, 13 patients who underwent operative treatment due to unstable elbow dislocation without associated fracture in the elbow joint were retrospectively reviewed in one tertiary trauma center. Patients presenting over 3 weeks from the original injury or with dislocation associated with coronoid, olecranon or radial head fractures were excluded. There were 11 male and 2 female with average age of 37 (range 18-72 years). There were 6 right elbows and 7 left elbows.

Cause of injury was fall from a height in eight, sports injury in three (two from Judo, one from triathlon), road traffic accident in two. Mean time from injury to operation was 3.5 days (range; 1-14 days).

Surgical indications of the unstable elbow were subluxation or non-congruent elbow joint on the radiographs

following closed reduction. Elbow dislocation which required extension block splint over 45 degrees to maintain reduction was considered as unstable elbow dislocation (Figure 1). MRI was taken in 10 patients to evaluate soft tissue injuries and associated intra-articular damage.

Data of pain scale, range of motion using goniometer, stability using manual stress test, and activity of daily living were collected for functional evaluation of Mayo Elbow Performance Score (MEPS).

Surgical technique

When dislocation is identified, reduction of the dislocation should be carried out first. Gentle closed reduction of elbow is recommended usually under general anesthesia. Repeated manipulation is not recommended to avoid further soft tissue and cartilage damage. Plain radiographs and MRI provide valuable information on which sides of soft tissue were damaged.

Examination under anesthesia should be carried out to confirm collateral ligament injuries. Valgus, varus and posterolateral rotatory instability testing were carried out. Valgus stability at forearm pronation, varus pivot

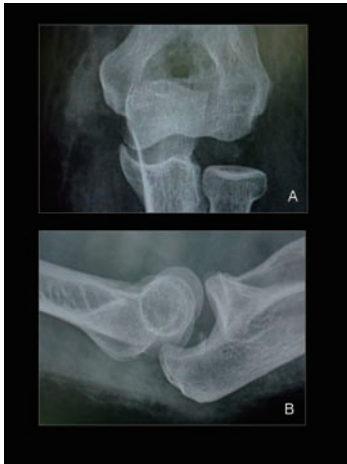


Fig. 1 A 23 year old man (Case number 10) sustained left elbow dislocation after a fall during mountain hiking. After closed reduction, plain radiographs of the elbow anteroposterior (A) and lateral (B) view show wide gap in the radiocapitellar joint and persistent subluxation.

shift testing confirmed unstable ulno-humeral joint. All test signifies the disruption of medial and lateral soft tissue structures.

Lateral collateral ligament complex was exposed using modified Kocher's posterolateral approach. In most cases, common extensor tendon together with lateral collateral ligament complex was torn and retracted from the lateral epicondyle (Figure 2). Torn posterolateral corner of the joint capsule and intra-articular fracture was carefully inspected. Torn edge of lateral collateral ligament complex was tagged and re-attached the anatomic attach site of the lateral epicondyle using metal suture anchor (Twifix, Smith & Nephew, Memphis, TN). Non-absorbable suture using bone tunnel method was used to repair the common extensor tendons.

Extensile medial approach was used to expose the medial collateral ligament together with flexor pronator tendon. Mostly, the medial collateral ligament and capsule was avulsed from medial epicondyle, and flexor pronator tendon was torn at musculotendinous junction. Medial collateral ligament was re-attached using anchor screw and for flexor/pronator tendons, non-absorbable sutures (5-0 Ethibond, Ethicon, Johnson & Johnson, Somerville, NJ) through bone tunnel in the medial epicondyle was used, because the anatomic attachment site was easily identified in the acute setting.

After re-attachment of medial collateral ligament, valgus/varus stress and pivot shift test were carried out to check integrity of lateral stabilizers. After re-attachment, concentric and congruent elbow joint during flexion and extension must be identified under the image intensifier. Trans-articular pin fixation was not recommended in any series.

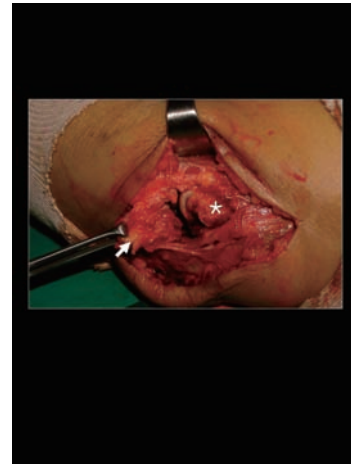


Fig. 2 At surgical exploration, common extensor tendons were torn apart from the lateral epicondyle and lateral collateral ligament complex (arrow) was avulsed from lateral epicondyle (asterisk), which were reattached using anchor screw and bone tunnel method.

Postoperative rehabilitation

Posterior splint is applied at 30 degrees of extension and arm was elevated to reduce postoperative swelling. Early active assisted range of motion exercise could start from 7 to 10 days after operation depending on the soft tissue condition. Posterior splint was applied during this time. Hinged plastic brace was applied afterwards and protected active flexion and extension were allowed from 2 weeks after operation.

Case presentation

A 43 year old male carpenter fell from a height in the construction filed. He had lumbar spine bursting fracture, which was stabilized with pedicle screw system. Right elbow dislocation was reduced manually before being transferred. The patient complained severe pain in the right elbow and physical examination showed extensive ecchymosis and subcutaneous hematoma along medial side of the elbow (Figure 3 A,B). No neurologic deficit was found at examination.

Plain radiographs at arrival showed non-congruent ulnotrochlear joint with radial shift of proximal radio-ulnar joint. Lateral radiograph showed complete dislocation of proximal radioulnar joint from distal humerus (Figure 3 C, D). There was no fracture in the distal humerus, coronoid or radial head. MRI demonstrated non-congruent elbow joint with persistent subluxation. High signal intensity on both medial and lateral sides of the elbow implied extensive soft tissue damage (Figure 4 A,B).

Examination under anesthesia showed unstable elbow joint medially, laterally and posteriorly. Medial approach



Fig. 3 A 43 year old carpenter injured his right elbow after a fall in the construction field. At physical examination, right elbow was very unstable at valgus (A) and varus (B). Plain radiograph of anteroposterior (C) and lateral (D) views demonstrated highly unstable elbow without congruent joint reduction. Concentric reduction was unable to achieve.



Fig. 5 After primary repair, early rehabilitation was possible and near full range of motion was regained at three months after operation (A,B). The patient reported minimal pain with no disturbance in activity of daily living. Functional score of Mayo Elbow Performance Score was 100 at last follow up. Plain radiographs (C,D) at latest follow up showed concentric reduction of the joint with no sign of instability, arthrosis or heterotopic ossification.

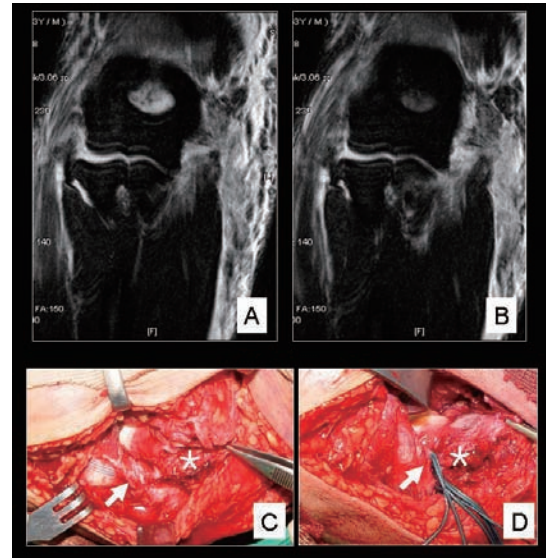


Fig. 4 T2 weighted coronal MR images showed extensive soft tissue damage on both medial and lateral side with persistent subluxation. (A,B). At exploration, flexor/pronator tendon (arrow) was torn at musculotendinous junction and medial collateral ligament and capsule were avulsed from medial epicondyle (asterisk) (C,D). Both medial and lateral structures together with anterior capsule were repaired using anchor screws and bone tunnel method.

exposed all flexor/pronator tendons were torn at musculotendinous junction or avulsed from medial epicondyle. Medial collateral ligament was usually torn from humeral side, Re-attachment using non-absorbable suture and anchor screws (Figure 4 C,D). Anterior capsule and coronoid process could be exposed and examined from medial side. After reattachment, there was significant varus and posterolateral rotatory instability persisted. Lateral ligament complex and capsule was torn from lateral epicondyle was retracted distally. After re-attachment, stable congruent elbow joint was achieved which was confirmed under image intensifier.

After the rehabilitation protocol, functional range of motion was achieved in three months, and no instability or traumatic arthrosis was noted at latest follow up (Figure 5).

Results

All patients were followed up clinically and radiologically at a mean time of 27 months (range, 12-37 months) after operation.

In ten patients, full stability was restored only after both medial and lateral ligaments were re-attached. In two patients, only lateral structure (LCLC and common extensor tendon) was repaired and in one patient, only medial structure (MCL and flexor pronator tendon) was

repaired for stability. In ten patients, flexor/pronator tendon was torn in musculotendinous junction and in three patients, there was small flake of bone avulsed from epicondyle. In one patient, persistent posterior subluxation was identified after medial and lateral structure repair, and repair of the torn anterior capsule and brachialis from the coronoid process was performed. Preoperative MRI showed soft tissue injuries and capsular tear with high signal intensity lesions. These have been identified during the operation.

Overall mean functional Mayo Elbow Performance Score⁹ was 93.5 (range 70-100).

Mean extension lag was 15 degrees (range; 10-30 degrees) and mean flexion was 130 degrees (range; 100-140 degrees). Mean prono/supination was 70/80 degrees (range; 50-90 pronation, 75-90 supination). No elbow was dislocated or subluxated during the operation and follow up period. Minor paresthesia or scar tenderness was reported by three patients but no further surgery was performed.

All patients returned to previous work level except one patient who had worker's compensation. Otherwise all ten patients returned to previous work level in average of 3.5 months.

Complications

Functional range of motion was not achieved in two patients. One had traumatic subdural hematoma which delayed the operative treatment and rehabilitation complicated. The other one patient had severe chest injury which delayed the rehabilitation program until 8 weeks. Both patients required open arthrolysis for the stiffness and achieved near functional range of motion at last follow up.

Three patients had mild ulnar nerve symptoms after operation. One of them required cubital tunnel decompression for the ulnar nerve. There was fibrous scar adhesion between the nerve and flexor pronator muscle below the medial epicondyle. Ulnar nerve symptoms of the other two patients resolved spontaneously in three months.

Heterotopic calcification was noted in 6 patients at last follow up. Massive heterotopic ossification in the brachialis muscle was identified in one patient who sustained traumatic subdural hematoma. This has been resolved in six months postoperatively and the patient refused further surgery, because the range of motion at last follow up was 30-110 degrees with no instability. Spotty calcification around the lateral epicondyle and along the lateral collateral ligament complex in five patients and calcification around the medial epicondyle in four and both in two.

Discussion

The elbow is the second most commonly dislocated joint next to the shoulder in the adults.¹⁰ Dislocation or subluxation typically occurs as a result of falls on the outstretched hand. Axial compressive force during flexion together with valgus moment results posterior dislocation.¹¹ Hyperextension injury to the elbow can produce elbow dislocation.² O'Driscoll introduced circle concept to the soft tissue disruption from lateral to medial in three stages and dislocation is the final of three sequential stages of elbow instability.¹⁰ Based on this concept, anterior band of MCL is the most important structure which becomes the centre of pivot for posterior dislocation. A study of anatomy, mechanism of injury and clinical features suggested that there were soft tissue injuries around the elbow joint. Although the roles of the flexor/pronator and common extensor origins are not fully understood, however they are probably crucial secondary stabilizers of the elbow.¹¹ In our series, all flexor/pronator and common extensors were disrupted in unstable elbow dislocations.

Acute simple dislocation of the elbow can be reduced under regional or general anesthesia. After stability assessment, early mobilization based on severity of soft tissue is recommended. Usually a total of 3 to 6 weeks of protected motion is adequate. (Hand Clinics) Reported clinical results in simple dislocation with early mobilization were mostly successful. Uncomplicated dislocations generally have very satisfactory results. Excellent results with full range of motion, normal strength, absent pain and good stability may expected in half of uncomplicated dislocations. However, complex fracture dislocation of the elbow showed somewhat different clinical results with various complications, such as instability, painful stiff elbow, etc.

According to Ring and Jupiter, instability of the elbow joint presents in two basic patterns: One is the olecranon and coronoid are fractured and inadequate fixation creates¹² an inadequate trochlear notch and the other one is the trochlear notch is either intact or repaired and there is dislocation or subluxation of the ulnohumeral joint. In the first pattern, stability can often be restored by achieving secure realignment of the fractured bones. In the second pattern restoration of stability depends on management of the radial head, coronoid process, and capsuloligamentous structures. In our study, we focused mainly on capsuloligamentous structure in complex instability without fracture.

Indication for acute ligament repair or reconstruction is instability that does not permit early protected motion in a cast brace. This usually occurs only when there are associated fractures. In such cases, the ligaments may have been avulsed and can be repaired directly to the bone with heavy sutures. If they are torn and can not be re-

paired, reconstruction of the ligament using palmaris longus tendon is recommended.¹³ In our experience, primary stabilization is preferred than late reconstruction procedure, because primary repair immediate after injury can avoid complicated reconstruction procedure with early return to previous work activities.

The ligamentous contributors included are the medial and lateral collateral ligament complex, and dynamic stabilizers are flexor/pronator group and common extensor/supinator group.¹⁴ The primary goal of the treatment for the unstable dislocation is to restore the essential element, the ulnohumeral joint by primary repair of disrupted collateral ligaments. The next step is to restore dynamic stability by repairing musculotendinous structure. Third step is to repair collateral ligament complex. A hinged external fixator is advised in certain circumstances in which it is desirable to protect a fracture or a ligament repair.

Josefsson and associates reviewed the long term sequelae of simple dislocation in 52 patients.⁷ Half of the patients had normal elbows; one third had some loss of motion, mainly extension. This related to the duration of post-reduction immobilization. Those immobilized longer than 3 weeks were likely to develop contractures, whereas those immobilized for shorter periods were not. In this series, all patients were advised to follow protected early rehabilitation within ten postoperative days.

There have been few reports on recurrent dislocation of the elbow in the literature.¹⁵ Previous operations can be classified into four groups. 1) Reichheim's operation which is transplantation of biceps tendon through the coronoid process, 2) Milch's and Wainwright's bone block procedure, which has mechanical effect on the coronoid process to prevent its disengagement under the trochlear through anterior approach, 3) Intra tendinous sling procedure using artificial ligament described by Kapel, 4) Knoflach and Spring's reinforcement of collateral ligaments. More recently, Nester and O'Driscoll¹⁶ reported free palmaris longus tendon graft using bone tunnel method. Primary ligament repair and ligament reconstruction have been reviewed and compared by Mayo group. They reported the clinical results were better in reconstruction group than primary repair group. None of the patients in this series, however, required late reconstruction and all achieved functional return to work.

Neurologic problems occur in approximately 20 percent of dislocation. The ulnar nerve is the most susceptible major nerve. Symptoms vary from transient paresthesia in the ulnar distribution to rare permanent ulnar nerve palsy.

Pugh *et al.*¹⁷ reported surgical outcome of 36 patients with elbow dislocation associated with both radial and coronoid fracture. They repaired collateral ligament with or without hinged external fixation. Overall average range of motion was $112^\circ \pm 11^\circ$ at a mean follow up of 36

months. Functional score using Mayo Elbow Performance Score was 88 points.

In conclusion, primary ligament repair for unstable elbow dislocations avoids late ligament reconstruction and prevents the poor results which are commonly found following non-operative treatment. An external fixator is not usually required in the acute setting. Clinical results from primary ligament repair in unstable elbow have been successful, because immediate motion was possible and stability has been achieved. The current approaches to start immediate motion in all injured and operated elbow; those for which this is not possible are reconstructed to permit such early motion. Further studies are required to validate our clinical results

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