



The effect of medial side repair in terrible triad injury of the elbow

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Objective: The aim of this study was to evaluate the effect of surgical repair of the medial collateral ligament and ulnar nerve release in cases of terrible triad injuries of the elbow.

Methods: This study included 16 patients (average age: 34 years) who underwent surgery following a diagnosis of terrible triad injury of the elbow between 1996 and 2007. Average follow up was 34.5 months. In all cases, the radial head was first fixed or replaced and the anterior capsule/coronoid complex and lateral collateral ligament were repaired. The medial side of the elbow was addressed (medial collateral ligament repair and ulnar nerve release) in 8 cases and not addressed in the remaining 8 cases. Range of motion, pain, stability, ulnar nerve symptoms, functional Mayo Elbow Performance Index, and Disabilities of the Arm, Shoulder and Hand scores were documented. Serial X-rays were used to confirm ulnohumeral arthritis and development of ectopic calcification. Ultrasonography or MRI was used to detect ulnar nerve entrapment.

Results: Range of motion was slightly more limited in cases where the medial side was not addressed. Ulnohumeral range of motion and flexion degrees were higher in the cases where the medial side was addressed ($p<0.05$). Serial X-rays demonstrated impending ectopic calcification located at the proximal insertion of medial collateral ligament in patients who did not undergo medial side repair. MRI or ultrasonography confirmed these findings, revealing swollen displaced nerves resembling findings similar to cubital tunnel syndrome.

Conclusion: Ulnar neuropathy is a common complication after medial collateral ligament injury and prophylactic release will facilitate overall results and postoperative patient satisfaction.

Key words: Elbow; medial collateral ligament repair; terrible triad injury.

Terrible triad injury of the elbow is defined as the posterior dislocation of the elbow joint in conjunction with fractures of the radial head and coronoid process.^[1-3] Pathoanatomy of this injury includes bony injuries and extensive disruption of the soft tissue critical for elbow stability which progresses from the lateral towards the medial side.^[4,5] As awareness of the importance of soft tissue components increased, surgeons became forced to revise treatment regimens to

address soft tissue injuries, as well as fractures. Recent studies report improved results using modern protocols that address each component of the injury. In these studies, medial collateral ligament (MCL) repair is considered the last step in the surgical treatment of patients with residual instability despite the radial head, coronoid process and lateral collateral ligament (LCL) repair.^[6-8] In this study, we aimed to evaluate the results of the surgical treatment of the medial side

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(MCL reconstruction and ulnar nerve release) in terrible triad injuries of the elbow.^[4,5]

Patients and methods

Twenty-seven patients with terrible triad injuries of the elbow underwent surgery within ten days of injury between 1996 and 2007. Preoperatively, significant ligament disruption was documented in all patients under general anesthesia by fluoroscopy and the elbows were graded as severely unstable. All patients had radial head fractures, coronoid fractures and posterior dislocations of the elbow documented by radiographs. Eleven patients did not meet the standard treatment protocols and were excluded from the study. The remaining 16 patients (5 women, 11 men; average age: 34 years, range: 24 to 50 years) formed a uniform group, with detailed documentation of the injured components and similar repair techniques with strict adherence to current treatment protocols that addressed each component of the injury (Table 1).

Group 1 consisted of 8 cases (4 women, 4 men; average age: 39.5 years; range: 26 to 50 years) in which cubital tunnel release and MCL repair was performed. The right elbow was affected in 5 patients and the left elbow in 3. A stable elbow was achieved following repair/replacement of the radial head, LCL and anterior capsule-coronoid complex repair. At the surgeon's discretion, the medial side of the elbow was also addressed. The radial head was replaced with a metal prosthesis in 3 patients and repaired with screws in 5 patients using the lateral approach. The coronoid fracture was fixed in 3 patients with Type 2 fractures, and anterior capsule was repaired with nonabsorbable sutures in 3 patients with Type 1 fractures.

In Group 2, the medial side was not addressed in the remaining 8 patients (1 woman, 7 men; average age: 31.2 years; range: 24 to 45 years). The right elbow was affected in 5 patients and the left elbow in 3. After replacement or osteosynthesis of the radial head and lateral collateral and coronoid-anterior capsular repair, the elbow was found stable and no further medial procedure was performed.

Ten right and six left elbows were operated. The average follow up period was 34.5 (range: 14 to 110) months. Fourteen elbows were injured in a fall and two in traffic accidents. All injuries were closed and there were no additional associated injuries to the involved extremity. Coronoid and radial head fractures were evaluated with radiographs in all patients. Computed tomography was performed in ten patients. Fractures were classified based on surgical exposure. Soft tissue

Table 1. Detailed data of the patients enrolled in the study.

Case	Age	Gender	Side	Coronoid fracture type	Radial head fracture type	Coronoid + capsule fixation	Radial head reconstruction	MCL repair and nerve release	Follow-up (months)	Flexion (degrees)	Extension (degrees)	Pronation (degrees)	Supination (degrees)	Arthritis grade (Broberg and Morrey)	Mayo elbow score	Mayo category	DASH score
1	44	F	R	1	3	Suture	Prosthesis	+	47	140	5	90	90	1	95	Excellent	4
2	37	F	L	1	3	Suture	Prosthesis	+	24	145	12	80	80	0	85	Good	16
3	35	M	R	2	3	Screw	Screw	+	76	135	0	90	90	1	100	Excellent	0
4	26	F	L	2	2	Screw	Screw	+	19	135	25	60	25	0	80	Good	32
5	50	M	R	1	3	Suture	Prosthesis	+	15	140	25	70	70	0	100	Excellent	6
6	33	M	R	1	2	None	Screw	+	18	130	0	90	90	0	100	Excellent	5
7	46	M	L	2	2	Screw	Screw	+	81	140	20	45	75	1	100	Excellent	0
8	45	F	R	1	3	None	Screw	+	16	145	12	80	75	0	100	Excellent	5
9	25	M	R	1	3	Suture	Plate	-	33	140	15	90	80	0	85	Good	6
10	34	M	L	1	3	Suture	Prosthesis	-	23	130	15	80	80	0	85	Good	12
11	26	M	R	2	3	Screw	Plate, screw	-	20	120	30	30	80	1	85	Good	20
12	26	M	R	2	3	Screw	Screw	-	14	130	20	45	70	0	100	Excellent	3
13	45	M	L	2	2	Screw	Screw	-	16	118	8	80	80	0	100	Excellent	4
14	24	F	R	1	3	None	Plate, screw	-	24	125	25	60	40	1	85	Good	12
15	32	M	L	1	2	None	Screw	-	110	135	0	90	90	1	100	Excellent	0
16	38	M	R	1	3	None	Prosthesis	-	17	120	18	70	70	0	85	Good	21

injuries were documented by MRI and ultrasonography. MCL, as well as LCL, were avulsed from the proximal insertions in all cases. There was gross instability in all elbows which was detected by physical examination under anesthesia.

Radial head fractures were classified according to the Broberg and Morrey modification of the Mason classification as Type 2 in three patients in Group 1 and two patients in Group 2, and Type 3 in five patients in Group 1 and six patients in Group 2.^[9,10] Coronoid fractures were classified according to Regan and Morrey's system as Type 1 in five patients in both Group 1 and 2 and as Type 2 in three patients in both groups.^[11]

All patients were operated within ten days of the initial injury. A lateral Kocher incision was used in all cases to repair the lateral structures. The LCL was reattached to its origin. In Group 2 patients, the radial head was replaced with a metal prosthesis in 2 patients and repaired with screws or plating in 6 patients using the lateral approach. The coronoid fracture was fixed with screws in 3 patients, the anterior capsule was secured to the coronoid base using a separate limited anteromedial incision in 2 patients, and the anterior side of the joint was not addressed in the remaining 3 cases. In Group 1, the medial side of the elbow was addressed using a separate medial incision. The cubital tunnel was opened, the ulnar nerve released in situ and the torn MCL was visualized and reattached to the medial epicondyle. External fixators were not used in either group. None of the cases in either group presented any instability at the end of the surgical procedure. A standard postoperative physiotherapy protocol was initiated within the first postoperative week for all patients. The operated elbows were protected by hinged elbow braces worn for 8 weeks. Indomethacin prophylaxis (75 mg/day) against heterotopic ossification was administered to all patients for 3 weeks.

Patients were evaluated postoperatively for an average of 34.5 months after the index surgery. Range of motion, pain, stability, ulnar nerve symptoms were assessed and functional Mayo Elbow Performance Index (MEPI)^[12] and Disabilities of the Arm, Shoulder and Hand (DASH)^[13,14] scores were documented. Conventional serial radiographs were used to detect the development of ectopic calcifications around the medial epicondyle. Radiographic signs of ulnohumeral arthritis were evaluated according to the criteria of Broberg and Morrey: Grade 0 (absent, normal elbow); Grade 1 (slight joint space narrowing or minimum osteophyte formation); Grade 2 (moderate joint space

narrowing or moderate osteophyte formation); and Grade 3 (severe degenerative change and joint destruction).^[9] Ultrasound or MRI was used to evaluate medial sided discomfort in symptomatic cases and to detect ulnar nerve entrapment.

Statistical analysis was performed using SPSS v11.0 (SPSS Inc., Chicago, IL, USA) software. The results of two groups were compared using independent samples t-test for differences in DASH, MEPI scores and range of motion values in all directions. The Fisher exact test was used to determine the relationship between elbow arthritis and MCL repair. Level of significance was defined as $p < 0.05$.

Results

All patients achieved a stable and functioning elbow postoperatively without any detected residual instability or valgus stress instability on physical examination.

For Group 1 patients, the average final arc of ulnohumeral motion was 126.4 (range: 110 to 135) degrees with an average flexion of 138 (range: 130 to 145) degrees and an average flexion contracture of 12.3 (range: 0 to 25) degrees at a mean follow-up period of 37 (range: 15 to 81) months. Average forearm rotation arc was 150 (range: 85 to 180) degrees with an average pronation of 75.6 (range: 60 to 90) degrees and an average supination of 74.4 (range: 25 to 90) degrees. Posttraumatic elbow arthritis was classified as Grade 0 in five patients and Grade 1 in three patients. Average MEPI was 95 (range: 80 to 100). The categorical ratings included 6 excellent and 2 good results. The average DASH score was 8.5 (range: 0 to 32). Six of the eight patients in Group 1 did not have any symptoms on the medial side of the elbow. The remaining two patients had mild pain not restricting the use of the elbow during daily activities. None of the patients had any signs or symptoms related to ulnar nerve impingement at the elbow. The Tinel test was negative at the cubital tunnel. Noticeable calcification was not detected around the medial epicondyle on radiographs (Fig. 1).

Group 2 patients had an average final ulnohumeral motion arc of 111 (range: 90 to 135) degrees with an average flexion of 127 (range: 118 to 140) degrees and an average flexion contracture of 16 (range: 0 to 30) degrees at a mean follow-up period of 32 (range: 14 to 110) months. Average forearm rotation arc was 142 (range: 110 to 180) degrees, with an average pronation of 68 (range: 30 to 90) degrees and an average supination of 73 (range: 40 to 90) degrees. Elbow arthritis was classified as Grade 0 in five patients and Grade 1 in three. Average MEPI was 91 (range: 85 to 100) with

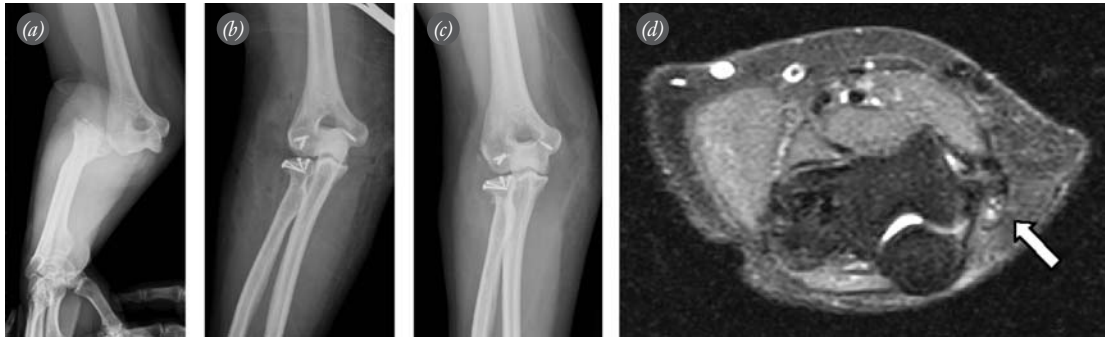


Fig. 1. (a) Preoperative and (b) early postoperative radiographs of a 45-year-old woman with a right terrible triad injury of the elbow. Surgical repair consisted debridement of the small coronoid fragments and fixation of the anterior capsule, radial head fixation with screws, lateral and medial collateral ligament repair by suture anchors and cubital tunnel release. (c) Postoperative 16th month radiographs demonstrate negligible amount of ectopic ossification at the medial epicondyle. (d) MRI shows near normal insertion of the injured MCL to the medial epicondyle and a normal cubital tunnel. The ulnar nerve is detected at the cubital tunnel without any signs of entrapment (arrow).

categorical ratings of excellent in 3 patients and good in 5. The average DASH score was 10 (range: 0 to 21). Persistent medial-sided pain on examination was present in 7 of the 8 cases on Group 2. Symptoms of ulnar neuropathy and positive Tinel sign were detected with no motor disturbance in 4 patients. These symptoms did not cause evident limitation on daily activities and the pain did not worsen during the day.

Range of motion was more limited in cases in which the medial side was not addressed than in those in which the medial side was operated. Differences in flexion ($p=0.04$) and ulnohumeral motion ($p=0.031$) were statistically significant between the two groups with better results in the repaired cases. However, MEPI scores did not reveal any difference. Serial radi-

ographs, taken postoperatively in Group 2 patients, demonstrated impending ectopic calcification located at the proximal insertion of the MCL (Fig. 2). This calcified tissue greatly reduced the space at the cubital tunnel, compressing and shifting the nerve away from the original path. MRI or ultrasonography confirmed these findings, revealing swollen displaced nerves resembling findings similar to cubital tunnel syndrome. MRI scans showed the ectopic ossification centers were actually located on the posteromedial side of the epicondyle, impinging on the ulnar nerve at the cubital tunnel (Fig. 3). The proximal insertion of the healed MCL was ill-defined, showing a scar tissue formation between the bone and the ligament, possibly inducing ectopic calcification at this location.



Fig. 2. (a) Preoperative and (b) early postoperative radiographs of a 26-year-old man with a right terrible triad injury of the elbow. Note that the medial side was not addressed in this case, surgical repair consisting of radial head and coronoid fracture and lateral collateral ligament. (c) Postoperative 12th month anteroposterior X-ray showing marked ectopic ossification around the medial epicondyle (arrow). (d) MRI showing ill-defined proximal insertion of the MCL, gross ectopic ossification in continuity with the medial epicondyle (large arrow), narrowing the cubital tunnel with a swollen, posteromedially displaced ulnar nerve at the cubital tunnel (small arrow).



Fig. 3. MRI scans for the same (a, b) 45-year-old and (c, d) 26-year-old patients in Figs. 1 and 2, confirming the ectopic ossification centers on the posteromedial side of the epicondyle, impinging on the ulnar nerve at the cubital tunnel.

Discussion

The MCL is regarded to be the primary stabilizer of the elbow. It is also considered a major constraint to forced internal rotation.^[15-19] Studies on elbow dislocations showed that the MCL was completely ruptured and avulsed from its epicondylar attachments on the humerus in all cases.^[5,20] Eygendaal et al. also showed significant residual damage to the MCL at long-term follow-up.^[21] More than half of these patients had radiographic evidence of valgus instability, which was correlated with signs of degenerative joint disease, ectopic ossification, pain, and a worse score. However, they showed no statistical difference between outcomes in patients receiving surgical treatment for ligamentous injuries following simple elbow dislocation than those who did not receive surgical treatment.^[17] These findings support the idea clearly demonstrated in the literature that the MCL should not be surgically repaired in terrible triad cases.^[22] In this study, we also did not detect any difference in the outcome of posttraumatic degenerative joint disease between the two groups. On the other hand, a significant difference in the amount of ectopic ossification and medial-sided pain between those patients who received surgical repair of the medial side addressed was evident in the short-term follow-up. There was also a slight difference in the range of motion between the two groups, with better results achieved in the repaired group. The ongoing medial side pain appears closely related to the symptoms of ulnar nerve impingement, which we believe were the major cause of the slight elbow motion limitation. Recent opinion states that MCL repair is not necessary. However, neglecting the medial-sided injury may cause impending impingement of the ulnar nerve at the cubital fossa due to the ectopic calcification forming at the edge of the torn medial collateral ligament as elbow stability is reconstructed by fixing the articular frac-

tures and repairing the LCL and by avoiding the valgus loads postoperatively.^[7,23-25]

The origin of the MCL lies slightly posterior to the axis of the elbow, creating a cam effect.^[15] This means that as elbow flexion is increased, the tension applied to the ligament increases proportionately, distracting the injury site when the elbow is splinted at 90 degrees of flexion after the operation.^[15] The conservative treatment of MCL ruptures forces the ligament to heal in a distracted position, possibly causing more scar tissue formation and ectopic calcification at the distracted injury site. The amount of ectopic calcification was different between the two groups, with none or very limited calcification detected when the MCL was tightly attached to its bony insertion. On the other hand, serial radiographs showed impending ectopic calcification at the postero-inferior quadrant of the medial epicondyle in all cases in which the MCL was not addressed. MRI clearly showed that this newly-formed bone was located between the torn proximal end of the MCL and its footprint on the medial epicondyle, which was regarded as a radiological sign of nonanatomic healing of the ligament. The injured proximal insertion of the MCL forms the floor of the cubital tunnel. Any pathologic tissue located within this confined space reduces the volume of the tunnel, giving rise to ulnar nerve impingement. Ultrasound and MRI clearly demonstrated the displacement and impingement of the swollen ulnar nerve and ongoing soft tissue and bony inflammation located around the medial epicondyle.

The study's small sample size was due to the scarcity of terrible triad injuries of the elbow. With such a limited patient population, it was not possible to predict if the anatomic healing of the MCL without ectopic bone formation at the injury site is related with better results. However, it appears that preventing impingement of the ulnar nerve at the cubital tunnel is very important for

long-term satisfaction of the patient with better results. The necessity of repairing the MCL in a surgically stabilized elbow is still under debate, but we advise that the ulnar nerve should be released when dealing with a terrible triad injury of the elbow in order to prevent nerve entrapment symptoms. Failure to perform this step may inevitably render the elbow painful, decreasing the success rate of a well-planned operation and physiotherapy.

Conflicts of Interest: No conflicts declared.

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