

Comparative analysis of surgical options for medial collateral ligament repair in terrible triad injury of the elbow

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Abstract

The aim of our study is to evaluate the clinical and radiologic outcomes in patients with terrible triad injury, who underwent surgical treatment with or without the medial collateral ligament (MCL) repair. Fourteen patients who underwent surgery with a minimum of 12-month follow-up (mean, 17 months) were reviewed. Based on the systematic treatment protocol, radial head fracture, lateral collateral ligament, and coracoid fracture were treated. Subsequently, torn MCL was repaired in 7 patients, whereas in the remaining 7 patients, the MCL was not treated. Range of motion, elbow function, and radiographs regarding the arthrosis and heterotopic ossification were assessed. At final follow-up, no significant differences were found in elbow motion or function between the groups with and without MCL repair; except the pronation and supination which had superior range in repair group. In contrast, radiologic findings such as the arthrosis were seen more frequently in patients without MCL repair than those with repair. Our results indicate the effect of MCL repair on elbow motion and function might be small, whereas osteoarthritic changes occurred more frequently in elbows without MCL repair.

Introduction

Terrible triad injury, first described by Hotchkiss,¹ is a rare fracture-dislocation combination which consists of the posterior elbow dislocation, fractures in the radial head and coronoid process.^{2,3} As the term indicates, outcomes of this combined injury have been traditionally poor due to deficient fracture fixation, consequent joint stiffness, instability and/or arthrosis.^{4,5} Recently, a systematic protocol for surgical treatment was advocated based on the anatomical and biomechanical knowledge.⁶⁻⁸ Although this algorithmic approach could lead to improve the outcomes in terms of elbow pain and its function,^{9,10} there remain some problems postoperatively including contracture, heterotopic ossification and arthrosis.¹¹

In order to determine optimal treatment method, several studies focused on the surgical options within the framework of the protocol.¹¹⁻¹³ Repair of the medial collateral ligament (MCL) is also a notable option for the protocol; it is regarded as the last step only in the case with residual instability despite the management of radial head, coronoid process and lateral collateral ligament (LCL). To date, it is still controversial whether surgical approach to the MCL should be performed or not.^{6,14,15} Therefore, the purpose of this study was to investigate clinical and radiologic outcomes after surgical treatment with or without a repair of the MCL in patients of the terrible triad injury.

Materials and Methods

A retrospective study was approved by the institutional review board of our institute. Between 2007 and 2013, two elbow surgeons treated 18 patients with terrible triad injury. All patients had fractures of the radial head as well as the coronoid process, and posterior elbow dislocation documented by radiographs. Of these patients, 4 patients were excluded from this study; two patients did not meet the treatment protocol and 2 patients did not have follow-up longer than 12 months. A total of 14 patients (4 females, 10 males; mean age: 47 years, range: 25-73 years) were enrolled in this study, which followed up postoperatively for a mean period of 17 months (range: 12-36 months) (Table 1).

Patients underwent surgical treatment based on the systematic protocol.⁶⁻⁸ The radial head was treated with open reduction and internal fixation (ORIF) or prosthesis through a lateral approach. The primary indication for prosthesis was to avoid deficient fixation in comminuted fractures, according to the previous reports.^{16,17} Large coronoid fractures were

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fixed with mini cortical screws or headless compression screws, whereas small fragments were treated with suture repair of the anterior capsule. Detached LCL was repaired subsequently. In all elbows, marked stability was achieved following treatments of the radial head, anterior capsule-coronoid complex and LCL. At the surgeons' discretion, torn MCL was repaired in 7 patients (repair group), whereas the remaining 7 patients underwent no further treatment for MCL (non-repair group, Figure 1). For the treatment of radial head fracture, we adopted a monopolar modular prosthesis (EVOLVE Modular Radial Head System; Wright Medical Technology, Arlington, TN, USA) or small locking plate systems (Synthes Locking DRP; Synthes, West Chester, PA, USA), supplemented with headless compression screws as necessary. For repairing the LCL, heavy braided non-absorbable suture with either Mitek suture anchors (DePuy Mitek, Raynham, MA, USA), Twinfix suture anchors (Smith & Nephew, London, UK) or bone tunnels used. Torn MCL was addressed using a medial approach, and all cases in the MCL repair group had a detachment of MCL from the medial epicondyle. The original attachment on

the humerus was carefully identified, and a suture anchor (Mitek or Twinfix suture anchors) was placed. Using two sutures from the anchor, the MCL were repaired to achieve an adequate tension on its anterior band. Torn common flexor muscle was also repaired tightly. Postoperatively, all patients were initially placed in a posterior plaster splint or long-arm cast. The arms were immobilized for one week, and then active and active-assist motion exercises were started. Patients began passive

motion exercises after union of fractures were identified. Full return to sports or labors was allowed after 6 months after surgery.

Patients were followed-up for a minimum of 12 months, and were assessed their clinical findings such as residual symptoms and range of motion (ROM). Radiographs were examined at the final follow-up, to identify pathological changes such as synostosis or heterotopic ossification. In addition, the Broberg and Morrey classification¹⁸ was applied to evaluate

ulnohumeral arthrosis; 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). In addition to assessment by a surgeon, blinded assessments by two elbow surgeons who were not involved in any treatments were examined for this study. Inter-observer reproducibility of grading by the three



Figure 1. A 56-year-old male fell off a ladder, sustaining a left terrible triad injury of the elbow. (A) AP and (B) lateral radiographs and (C, D) CT with 3D reconstruction showed the elbow after closed manipulative reduction. A systematic surgical treatment without repair of the MCL was performed. (E) AP and (F) lateral radiographs showed the elbow at final follow-up, 17 months after surgery. A mild spur in medial side of the joint was developed through the follow-up. He had no pain and excellent function at final follow-up.

Table 1. Study population demographics and treatments.

	MCL repair group (n=7)	MCL non-repair group (n=7)	P values
Demographics			
Sex (female:male)	1:6	3:4	0.56
Age at time of injury	51 y (range, 25-66)	42 y (range, 25-73)	0.22
Side (left:right)	3:4	3:4	1.00
Radial head treatment			
ORIF	5 patients	6 patients	0.60
Prosthesis	2 patients	1 patient	
Coronoid/anterior capsule fixation			
ORIF	4 patients	4 patients	0.72
Capsular suturing	2 patients	1 patient	
None	1 patient	2 patients	
Follow-up period	17 mo (range, 12-36)	17 mo (range, 12-34)	1.00

MCL, medial collateral ligament.

Table 2. Clinical and radiologic outcomes.

	MCL repair group (n=7)	MCL non-repair group (n=7)	P values
Range of motion			
Flexion	133° (range, 120-140)	131° (range, 120-140)	0.79
Extension	-7° (range, -20-0)	-13° (range, -20-0)	0.16
Pronation	76° (range, 60-90)	54° (range, 40-70)	0.01*
Supination	86° (range, 80-90)	71° (range, 40-90)	0.03*
Arc of motion	126° (range, 100-140)	118° (range, 100-140)	0.40
MEPI			
Score (0-100 points)	95 (range, 80-100)	92 (range, 80-100)	0.48
Category: excellent	5 patients	4 patients	
Category: good	2 patients	3 patients	
Arthrosis grade			
Grade 0	5 patients	2 patients	0.23
Grade 1	2 patients	4 patients	
Grade 2	-	1 patient	

MCL, medial collateral ligament.

investigators was considered moderate (Fleiss' kappa coefficient =0.493).¹⁹ Changes of arthrosis grades between postoperative radiographs and those at the final follow-up period were analyzed in consensus by three investigators. Moreover, the relationship between the grades at the final follow-up and patients' age were also analyzed to assess the effect of patients' age on the progression of arthrosis. The Mayo Elbow Performance Index (MEPI),²⁰ which consists of items for pain, arc of motion, stability, and functional disability, was used for the assessment of elbow function at the final follow-up. The Scores of >90 were considered excellent, 75-89 as good, 60-74 as fair, and <60 as poor.

Statistical analyses were performed using the softwares, GraphPad Prism (version 5.0, San Diego, CA, USA) and JMP Pro (version 10.0, Cary, NC, USA). The Wilcoxon rank-sum test was used for continuous variables including some demographic data, and the results of MEPI scores or ROM values in all directions. Pearson's chi-square test or Fisher's exact test were used for categorical variables including the other demographic data and the results for osteoarthritic grades. In addition, simple regression analysis was used to assess the relationship between the patients' age and the osteoarthritic grades at the final follow-up. The level of significance was set at P=0.05.

Results

Clinical and radiologic outcomes are shown in Table 2. At the final follow-up, the mean total arc of elbow motion was 126° (range, 100-140°) for the repair group, and 118 (range, 100-140°) for the non-repair group. No significant differences were found in the ROM at the final follow-up between the groups, except in pronation-supination; the repair group showed an average of 76° (range, 60-90°) in pronation and 86° (range, 80-90°) in supination, which was significantly greater than that of the non-repair group with average 54° (range, 40-70°) in pronation and 71° (range, 40-90°) in supination (P=0.01, 0.03, respectively). According to the MEPI, both groups demonstrated satisfactory recovery in elbow function. No significant differences were found in MEPI at final follow-up between the groups (mean, 95 for the repair group versus 92 for the non-repair group, P=0.48).

In this series, all patients obtained union of fractures as well as stability of the elbow joints. Further surgery was not required in any patients. In postoperative radiographs, there were 2 patients with heterotopic ossification: both patients were in the non-repair group and resulted in satisfactory outcomes at the final follow-up. Regarding the Broberg and Morrey

classification for assessment of arthrosis, 5 elbows in the repair group and 2 elbows in the non-repair group had no changes (grade 0). Six of the residual 7 elbows had mild degenerative changes (grade 1), whereas, one in the non-repair group demonstrated a grade 2

change. He could return to the former work with minimal symptoms. Advanced osteoarthritic grades from postoperative timing to final follow-up were shown in 1 patient from MCL repair group and 4 patients from non-repair group (Figure 2). The grades at the

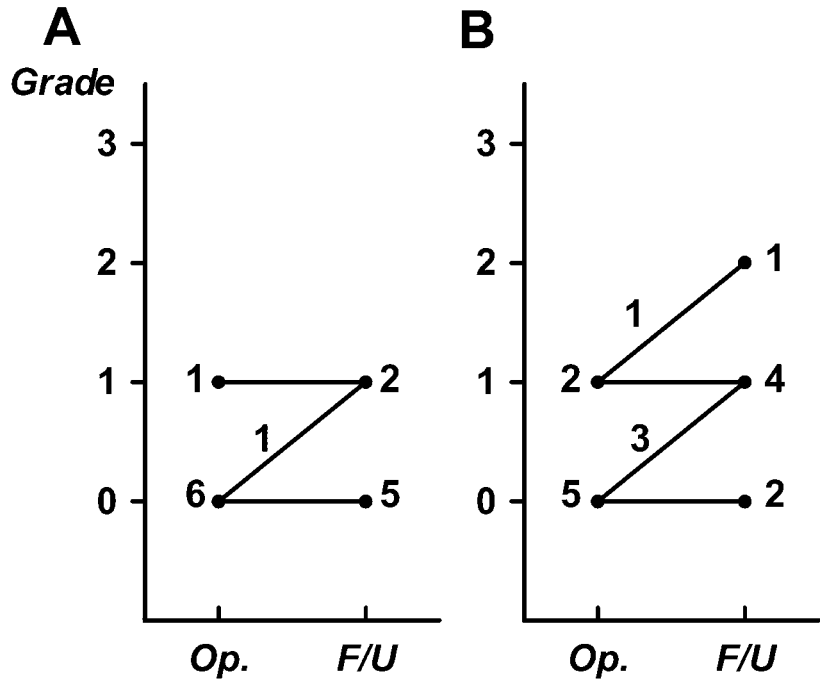


Figure 2. Radiologic changes of osteoarthritic grading from postoperative to the final follow-up period in MCL repair group (A) and non-repair group (B). Each number in the figure represents patients' number with each radiologic grade, based on the Broberg and Morrey classification.²⁰ Lines represent the changes in the grades from postoperative period (Op.) to the final follow-up period (F/U).

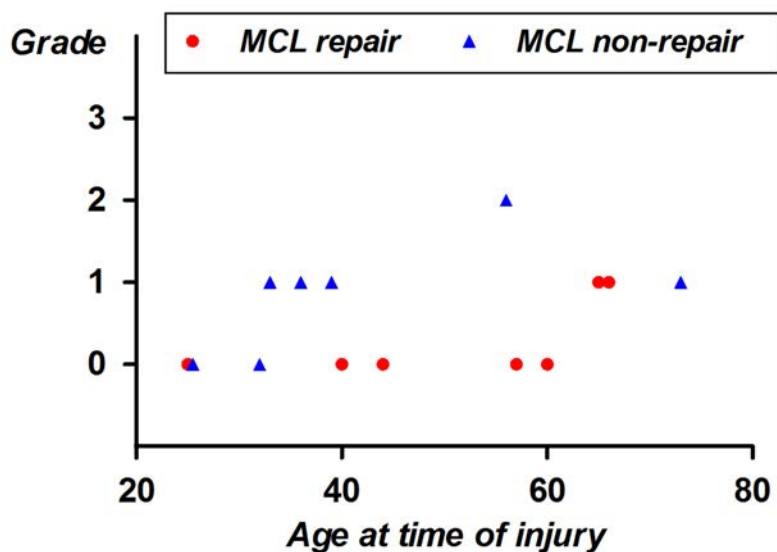


Figure 3. The relationship between the radiologic arthrosis at final follow-up and the patients' age at the time of injury. Osteoarthritic grades based on the Broberg and Morrey classification²⁰ were not significantly correlated with the patients' age (R=0.36).

.final follow-up were no significantly correlated with patients' age ($R=0.36$, Figure 3).

Discussion

An organized treatment protocol of terrible triad injury has been developed to improve clinical outcomes including symptoms and elbow function.^{9,10} In contrast, several studies indicated considerable problems such as instability, contracture, reoperation, and/or progression to arthrosis still remains even after this surgical approach.^{11,14} Thus, within the framework of this systematic protocol, some authors investigated further into its surgical options in detail; indication of radial head prosthesis despite the ORIF,^{11,12} validity to repair coracoid fractures,¹³ necessity to treat the medial side after restoring other components,^{6,14,15} and so on. As for the treatment of MCL, a number of studies investigated the anatomy and its functional behavior associated with elbow motion.^{21,22} It is well known that the MCL is completely ruptured and avulsed from its epicondylar attachment on the humerus in most cases with elbow dislocation.^{23,24} Considering its role of the primary stabilizer of the elbow joint, surgical management of repairing the torn MCL seems to be warranted.²⁵⁻²⁷ Nevertheless, a previous study as for simple elbow dislocation showed no significant differences in the clinical outcomes between patients who received surgical repair and those without surgery.²⁶

Regarding the terrible triad injury, Forthman *et al.*⁶ reviewed 22 patients who underwent surgical treatment without repairing the MCL, and concluded that MCL repair was unnecessary in obtaining satisfactory outcomes with surgical treatment. Contrarily, Jeong *et al.*¹⁴ recommended repairing the MCL based on their clinical experiences of 8 patients who underwent the primary repair. Toros *et al.*¹⁵ compared the clinical and radiologic outcomes between patients who underwent surgical treatment of medial side (MCL repair and ulnar nerve release) and those without treatment for medial side. They showed no differences in functional scores between the two groups, whereas the treated group showed better improvement in some parts of elbow motion than the non-treatment group. In addition, they reported heterotopic calcification was present in the non-treated group with residual symptoms. Therefore, although the necessity of repairing the MCL is still under debate, our results support these previous reports; postoperative elbow function was not necessarily affected by the supplementation of MCL repair to the systematic treatment for the terrible triad injury. In contrast, based on the evidence, we have to pay a cau-

tious attention for radiologic changes including arthrosis as well as heterotopic mineralization (ossification or calcification). Even with use of the established guideline, postoperative arthrosis still remains with the prevalence of approximately 8-67% over 1-year follow-up.^{6,15,28} To date, several studies have suggested that the development of post-traumatic arthrosis may be associated with the injury pattern and amount of energy absorbed within the joint.^{29,30} Further large-scale studies should be required to determine if such pathological findings could occur in association with unrepaired MCL, as indicated in our study.

There were several limitations in this study. First, the number of patients was relatively small for a comparative study. Second, it was a retrospective study; therefore, imbalanced patients' characteristics (*e.g.* gender, patients age at injury), and the choice of MCL treatment depended on surgeons' discretion are noted. In order to identify the definite effect of additional MCL treatment on the clinical outcomes, further prospective analysis with randomized, research based criteria should be required. Especially, blinded comparison between MCL repaired and unrepaired elbows might clarify the progression of radiologic changes, such as arthrosis and heterotopic ossification, in association with varied MCL treatments. Third, the follow-up period in this study was at a minimum of 12 months, which considered a short-term assessment. However, we believe this study could provide useful information regarding the short-term effect of MCL repair.

Conclusions

The clinical effect of MCL repair on elbow function may be small. Our radiologic analysis also demonstrated osteoarthritic change might be present more in elbows without MCL repair.

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