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The effect of early surgical treatment on functional outcomes in terrible triad of elbow: a comparative study

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ABSTRACT

Objectives: In our study, we aimed to evaluate the effect of early surgical treatment on functional results in the terrible triad of the elbow.

Methods: Fifty-four patients operated for the terrible triad of elbow (TTE) injuries were included in the study. The study groups were determined as Group A (operated within 24 hours) and Group B (operated after one week). The same surgical procedure and rehabilitation program were applied to all patients. The follow-up period was 16.4 ± 8.4, with a minimum of 6 months. In the last follow-up, the flexion-extension range and supination-pronation interval were evaluated. Mayo Elbow Performance Score (MEPS) and Oxford Elbow Score were used for functional scoring.

Results: There was no significant difference between the two groups in terms of age, gender, injury type, and fracture classification. Elbow motion in group A was higher than in group B ($p < 0.01$). Moreover, group A had better higher MEPS and Oxford Elbow Score, an excellent and good rate than group B at the final clinical visit ($p < 0.01$). No postoperative pain or complication rate differences were found between the two groups.

Conclusions: Early operation for TTE patients resulted in better functional recovery than delayed operation.

Keywords: Terrible triad, elbow dislocation, early surgical treatment

Dislocation of the elbow accompanied by radial head and coronoid fracture has been named by Hotchkiss as a terrible triad of elbow [1]. Typically occurs with axial and valgus trauma to the elbow while the forearm is in supination [2, 3]. Surgical treatment is required because it causes instability in the elbow joint. Elbow fracture-dislocations are difficult to treat and have poor outcomes [4]. The primary goal of treatment is to provide stable fixation that will allow early elbow movements. Radial head fixation or arthroplasty, coronoid fixation, and lateral collateral ligament complex (LCLC) repair constitute the standard treatment [5, 6]. Despite all treatment protocols, pain, joint stiffness, instability, osteoarthritis are common complications [7, 8]. The optimal time for surgical treatment is controversial publications are reporting that the frequency of joint stiffness is high in patients operated after two weeks [9, 5]. In our study, we aimed to show the effect of early surgical treatment on functional results.

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METHODS

This study was started retrospectively with the approval of Istanbul Training and Research Hospital's Ethics Committee dated 06.12.2019 and numbered 2102. Fifty-four patients who were operated on with a terrible triad of elbow between 2011 and 2019 were included. Inclusion criteria are the following: (1) Being over 18 years of age, (2) Previously normal elbow functions, (3) No additional diseases affecting joint movements, (4) Applying the same surgical protocol (combined medial-lateral approach), and (5) At least 6 months of the follow-up period. The patients were divided into two study groups those operated within 24 hours (Group A) and those operated on after one week (Group B). Group A consists of twenty-eight patients and Group B consists of twenty-six patients. Ten patients were operated on late due to delayed admission to the hospital and nine patients were operated on late due to preoperative anesthesia preparation. In addition, seven patients were operated on late due to open fractures. Coronoid fractures were classified according to Regan-Morrey classification, radial head fractures according to Mason-Johnston classification.

Surgical Technique

Closed reduction and long arm splint were applied to all patients after vascular and neurological examination in the Emergency Service. Fracture components were determined by CT (computed tomography). In standard therapy, coronoid fracture fixation, radial head fracture fixation or arthroplasty, lateral collateral ligament complex (LCLC) repair was performed using a combined medial and lateral approach. Medial collateral ligament (MCL) repair was also performed in patients with persistent instability (Fig. 1).

Postoperative Care and Follow-up

A long arm splint was applied to all patients postoperatively. Antibiotic prophylaxis was started for 72 hours. 25 mg indomethacin was continued for six months, three times a day. In the follow-up in the second week, the long arm splint was removed, surgical sutures were removed, and an angle-adjusted elbow brace was applied. Passive movements were initiated in the 30°-90° flexion-extension range until the 1st-month follow-up. Active flexion-extension and supination-pronation exercises were started in the 1st month. Bone union was followed by direct radiography at every control. Flexion-extension, supination-pronation range were recorded during his follow-up for at least six months. Mayo Elbow Performance Score (MEPS) and Oxford Elbow Score were used for functional scoring. Complications and visual analog scale (VAS) pain scale were recorded (Fig. 2).

Statistical Analysis

SPSS 22.00 program was used for data analysis. Mean, standard deviation and ratio were used in the descriptive statistics of the data. Kolmogorov-Simirnov test was performed for the distribution of variables. The Mann-Whitney U test was used for the

Fig. 1. (a, b) preoperative X-ray scans show that terrible triad of elbow, (c, d) postoperative X-ray scans show that anatomical repair of bony and soft structures.

Fig. 2. Clinical photos at 12 months after surgery reveal excellent clinical outcomes.

analysis of quantitative independent data, and the Chi-square test or Fisher test was used for the analysis of qualitative independent data. The statistical significance level was determined as $p < 0.05$.

RESULTS

Fifty-four patients, including 40 men and 14 women, were included in the study. The patients who operated within 24 hours were determined as Group A (n = 28), and the patients who operated after one week as Group B (n = 26). Group A had twenty male and eight female patients, and Group B had twenty male and six female patients. The mean age was 40.14 ± 11.6 years in Group A, and 38.5 ± 14.8 years in Group B. According to the cause of trauma, 18 (33.3%) patients were admitted to the emergency service after a traffic accident, 24 (44.4%) patients with a fall from a height, and 12 (22.2%) patients with a simple fall. Thirty-two

Table 1. Preoperative data among two groups

	Group A	Group B	*p* value
Gender (Male/Female)	20/8	20/6	0.645
Age (Years)	40.14 ± 11.6	38.5 ± 14.8	0.861
Injury			0.196
Traffic accident	12	6	
Fall from height	12	12	
Simple fall	4	8	
Left/Right	16/12	16/10	0.743
Regan-Morrey			0.037
I	16	6	
II	8	12	
III	4	8	
Mason-Johnston			0.355
I	14	8	
II	8	10	
III	6	8	
Follow-up (Months)	18.4 ± 8.6	16.3 ± 8.5	0.445

(59.2%) patients were operated on the left elbow and 22 (40.9%) on the right elbow. According to the Regan-Morrey coronoid fracture classification, 22 (40.7%) patients were typed 1, 20 (37%) patients were typed 2, and 12 (22.2%) patients were type 3. According to the Mason-Johnston Radius head fracture classification, 22 (40.7%) patients typed 1, 18 (33.3%) patients typed 2, and 14 (25.9%) typed 3. Our average follow-up period was 16.4 ± 8.4 months, at least 6 months (Table 1).

Elbow Functional Outcomes

Patients in group A showed better elbow flexion-extension and forearm rotation recovery than those in group B (range of elbow flexion-extension 135 ± 18.7 to 117.7 ± 10.1, p < 0.01; forearm rotation 160 ± 28.5 to 132.3 ± 19.6, p < 0.01) (Table 2).

In addition, at the final clinical visit, the total MEPS (94.2 ± 9.3 to 86.1 ± 7.4, $p < 0.01$) and Oxford Elbow scores (44.2 ± 5.5 to 38.9 ± 4.4, $p < 0.01$) in group A was higher than group B which indicates that op¬erations performed earlier were associated with regaining better elbow function (Table 3).

In Group A, two patients had osteoarthritis, one patient had heterotopic ossification, and five patients had joint stiffness. In group B, three patients had osteoarthritis, one patient had ulnar nerve deficit, two patients had heterotopic ossification and six patients had joint stiffness. The VAS score was 2.71 ± 1.38 in group A and 3.38 ± 1.12 in group B (Table 4).

Table 2. Comparison of joint range motion among two groups

	Flexion-Extension Range (Mean ± SD)	Supination-Pronation Range (Mean ± SD)
Group A	135 ± 18.7	160 ± 28.5
Group B	117.7 ± 10.1	132.3 ± 19.6
***p* value**	**< 0.01**	**< 0.01**

SD = standard deviation

Table 3. Comparison of MEPS and Oxford elbow score

	MEPS (Mean ± SD)	Oxford Elbow Score (Mean ± SD)
Group A	94.2 ± 9.3	44.2 ± 5.5
Group B	86.1 ± 7.4	38.9 ± 4.4
***p* value**	**< 0.01**	**< 0.01**

MEPS = Mayo elbow performance score, SD = standard deviation

DISCUSSION

Terrible triad of elbow are injuries that damage bone and ligament structures, leading to instability [7, 10, 11, 2]. Therefore, almost every patient requires surgical treatment [5, 12, 13]. The treatment protocol is generally radial head fixation or arthroplasty, coronoid fracture fixation, LCLC repair, and MCL repair in patients with persistent instability [14-17]. Despite all treatment protocols and ideal bone and soft tissue reconstructions, they are injuries with high complication rates [4, 18, 19].

Complex elbow dislocations are complicated injuries that are challenging to treat; however, not all of these injuries are equivalent. Understanding elbow biomechanics and the mechanism of injury provides valuable insight into the variations of pathology that may be observed. Identification of the particular fracture pattern encountered helps guide appropriate treatment. Systematic protocols to address these injuries have resulted in improved functional outcomes through the optimization of elbow stability and articular congruency. Although results are often acceptable, complex elbow dislocations still frequently result in residual elbow stiffness and arthrosis. Further investigation into methods of fixation following complex

Table 4. Complications and VAS score among two groups

	Group A	Group B	*p* value
Osteoarthritis	2	3	0.663
Nerve deficit	0	1	0.481
Heterotopic ossification	1	2	0.604
Elbow stiffness	5	6	0.634
VAS	2.71 ± 1.38	3.38 ± 1.12	0.33

VAS = visual analog scale

elbow dislocations should continue the trend of improved patient outcomes [8].

When the literature is reviewed, there is a consensus about better results in early surgical treatment. McKee *et al*. [5] reported in their study that the incidence of joint stiffness was low in the early surgical treatment group. Lindenhovius et al. [9] in their study with 36 patients, two study groups were determined as those who were operated on within two weeks (acute) and those who operated on for more than three weeks (subacute). The same surgical protocol was applied to all patients. A better flexion-extension arc was found in the study group compared to the control group [9]. Zhou et al. [20] evaluated fifty-eight TTE patients by dividing them into three study groups. Group A was determined to be operated on within 24 hours (emergency), Group B operated between 24 hours and two weeks (early) and Group C operated after two weeks (delayed). The same surgical protocol was applied to all patients. Range of motion was compared between the groups at the first, third and sixth-month follow-up. MEPS was used for functional scoring at the sixth-month controls. While there was no significant difference between the emergency and early operated groups in the long-term controls, a better range of motion was observed in both groups compared to the delayed operated groups [20]. The clinical difference between early and late surgical treatment may be due to the alteration of soft tissues. Fracture hematoma occurs early in the injury, soft tissues become congestive. Inflammatory mediators are released between 24-48 hours and the process of necrosis begins with cell degeneration. This chain can be broken with early surgical treatment. In addition, as time passes, capsule contracture and muscle atrophy begin to appear. This makes it difficult to gain range of motion. In addition, soft tissues and bone fragments can be better identified in early surgical treatment, which benefits anatomical reduction and fixation. After the good repair of bone and soft tissues, patients can start their functional exercises early.

The general approach in open fractures is to wait for wound healing after wound debridement. This can prolong the time to surgery and lead to poor results. However, studies have shown that Gustilo type 1 and 2A are more common in open elbow dislocations [20, 21]. In our study, four patients in Group A had Gustilo tip 1 open elbow injury. We performed urgent debridement and repair operation within 24h but wound infection did not develop in any patient. Therefore, open terrible triad of elbow can be treated early after complete debridement.

CONCLUSION

In summary, terrible triad of elbow has many complications and poor prognosis. There are many factors that effect the results. The common opinion for good results is to achieve stable joint and early rehabilitation. When the literature is reviewed, there are no comprehensive studies examining studies the effect of time to surgery on outcomes in terrible triad of elbow. In our study, we showed that early operation for TTE patients resulted in better functional recovery than delayed operation. Although it varies according to the wound condition in open TTE patients, closed TTE patients should have an early operation.

Authors' Contribution

Study Conception: BA, EÇ, SS; Study Design: BA, EÇ, SS, AD; Supervision: BA, EÇ, SS; Funding: EG; Materials: BA, SS; Data Collection and/or Processing: BA, SS; Statistical Analysis and/or Data Interpretation: BA, SS; Literature Review: BA, EÇ; Manuscript Preparation: BA, EÇ and Critical Review: SS.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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