ORIGINAL ARTICLE

European Archives of Medical Research

DOI: 10.14744/eamr.2025.32744
Eur Arch Med Res 2025;41(2):75–80

Clinical Outcomes of Anterior Capsulodesis in Terrible Triad Elbow Injuries

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ABSTRACT

Objective: Terrible triad elbow ınjury (TTEI) is a complex trauma characterised by posterolateral dislocation, radial head fracture, and coronoid process fracture. Such injuries can lead to elbow instability and loss of function. The role of anterior capsulodesis surgery in the treatment of TTEI has not been fully established. The aim of this study was to evaluate the efficacy of anterior capsulodesis in patients with TTEI, to see its effect on elbow functional scores, to analyze possible post-operative complications, and to compare them with the literature.

Materials and Methods: This retrospective study analyzed 14 patients diagnosed with TTEI between 2017 and 2022. Patients with O'Driscoll type I-II and Regan–Morrey type I-II fractures were treated with a treatment protocol that included radial head fixation, lateral collateral ligament repair, and transosseous anterior capsulodesis. The mean follow-up was 23.2 months. Surgical outcomes were assessed using the Mayo Elbow Performance Score, Disabilities of the Arm, Shoulder, and Hand, and Broberg–Morrey classification.

Results: This study suggests that endobutton fixation of O'Driscoll and Regan–Morrey type I-II coronoid fractures in the treatment of TTEI has a positive effect on elbow function in the medium and long term. In particular, for fractures with limited coronoid involvement and capsular avulsion, anterior capsulodesis has been shown to improve functional outcomes and reduce the incidence of post-traumatic osteoarthritis.

Conclusion: Anterior capsulodesis is an effective option for the treatment of TTEI in terms of improving elbow function and reducing complications. When we reviewed the available studies in the literature, we concluded that anterior capsulodesis is a valuable procedure in the treatment of TTEI.

Keywords: Anterior capsulodesis, Elbow instability, Lateral collateral ligament repair, Mayo elbow performance score, Terrible triad elbow injury

Cite this article as: Aktan C, Acar B, May H, Karademir H. Clinical Outcomes of Anterior Capsulodesis in Terrible Triad Elbow Injuries. Eur Arch Med Res 2025;41(2):75–80.

INTRODUCTION

The "Terrible Triple Elbow Injury" (TTEI) was first described by Hotchkiss. This injury involves posterolateral dislocation, fracture of the radial head, and fracture of the coronoid process. Stiffness is associated with unfavorable outcomes such as recurrent instability and reduced range of motion (ROM). It is therefore known as the "terrible triad."[1]

The main aim of treating these injuries is to restore the stabilizing bony structures of the elbow. Surgical treatment became popular after it was realized that non-operative treatment

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Submitted: 06.03.2025 **Revised:** 18.03.2025 **Accepted:** 21.03.2025 **Available Online:** 04.06.2025

European Archives of Medical Research – Available online at www.eurarchmedres.org

methods did not give very good results.[2] The principle of surgical treatment is based on two main objectives: Restoration of the bone stabilizers (radial head and coronoid process) and reconstruction of the soft-tissue stabilizers (radial collateral ligament).[3]

Miyazaki et al.[4] concluded that stable fixation of the coronoid process, restoration of the anatomy of the radial head by fixation of the fracture or radial head replacement, lateral stability by repair of the lateral ligament complex, and repair of the medial collateral ligament (MCL) if instability persists are the keys to preventing residual instability.

Despite advances in clinical knowledge and surgical techniques, there is still no standardized treatment protocol for TTEI. Although the pathoanatomy of this injury is now better understood, treatment algorithms remain controversial. To our knowledge, no study in the literature has specifically evaluated the efficacy of anterior capsulodesis in patients with terrible elbow triad (TTEI) presenting with O'Driscoll type I-II and Regan–Morrey type I-II coronoid fractures.[5,6] We hypothesized that anterior capsulodesis would have a beneficial effect on clinical and functional elbow outcomes. The aim of this study was to investigate the efficacy of anterior capsulodesis in patients with TTEI, and its effect on functional elbow outcomes, analyze the incidence of post-operative complications, and compare it with the literature.

MATERIALS AND METHODS

Study Design

This study was designed as a retrospective analysis of patients aged 18 years and older who presented to the emergency department of the Antalya Training and Research Hospital Orthopedics and Traumatology Department with a terrible triad of the elbow injury between 2017 and 2022. Patients were identified through a review of hospital records, including medical charts and imaging studies. The study protocol was approved by the Institutional Review Board of our hospital (Approval No: 19/27–December 05, 2024).

This study was conducted in accordance with the Declaration of Helsinki and relevant ethical standards. As the study is retrospective in design, informed consent from participants was not required. However, participant confidentiality was maintained, and all ethical guidelines were strictly followed.

Patients

A total of 14 patients met the inclusion criteria and were included in the study. Four patients were excluded due to the unavailability of clinical outcome data.

Inclusion Criteria

- Age ≥18 years
- Diagnosis of TTEI with an O'Driscoll type I-II or Regan–Morrey type I-II coronoid fracture
- Completion of outpatient follow-up.

Exclusion Criteria

- Patients who underwent radial head excision or prosthetic replacement
- Patients who underwent MCL repair
- Patients who did not undergo anterior capsulodesis.

All included patients underwent radial head fixation, lateral collateral ligament (LCL) repair, and transosseous anterior capsulodesis (Fig. 1). Demographic data, including age, sex, and mechanism of injury, were recorded for each patient.

Surgical Methods

The mean time from injury to surgery was 79 h. Written informed consent was obtained from all patients preoperatively. The operations were performed by the same surgical team using only a lateral incision. First, the fracture fragments of the radius head were removed, and then the anterior capsule and coronoid structure were evaluated. The attachment site of the anterior capsule was examined with the index finger, and the avulsed anterior capsule was fixed using transosseous tunnels and endobuttons with the elbow flexed 90°. Flexion and extension ROM were evaluated after fixation.

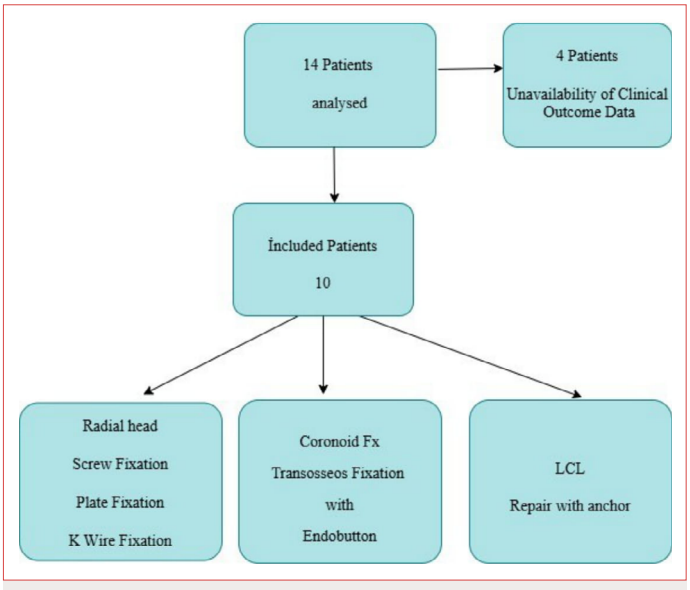

Figure 1. Included patients and surgical treatment flow chart.

Radial head fractures were fixed with headless screws, K-wires or plates (Fig. 2). Radial head excision or arthroplasty was not performed in any patient. According to the operative notes, eight patients had a complete tear of the LCL, and two patients had a 50% tear. In all cases, the LCL was repaired with transosseous sutures. Repair of the MCL was not required. Coronoid tip fractures were not fixed with plates or screws (Fig. 3).

Post-Operative Management

Post-operative follow-up was performed by the same surgical team. The arms of all patients were followed up in a long arm splint for 2 weeks postoperatively. Then, active ROM exercises were started after the splint was removed. Follow-up visits were weekly for the 1st month, monthly for the next 6 months, and then annually.

However, functional scoring and staging were performed by another independent orthopedist to rule out post-operative bias. Functional assessment was performed at the last follow-up visit using the Mayo Elbow Performance Score (MEPS).[7] The Disabilities of the Arm, Shoulder, and Hand (DASH) score was recorded at the last follow-up visit to assess post-operative functional capacity.[8] Radiological examinations were performed using the Broberg and Morrey classification system to assess arthritis changes.[9] Anteroposterior and lateral radiographs were also used to analyze fracture healing and joint alignment. Both DASH and MEPS scores were recorded by patients using online scoring platforms.[10]

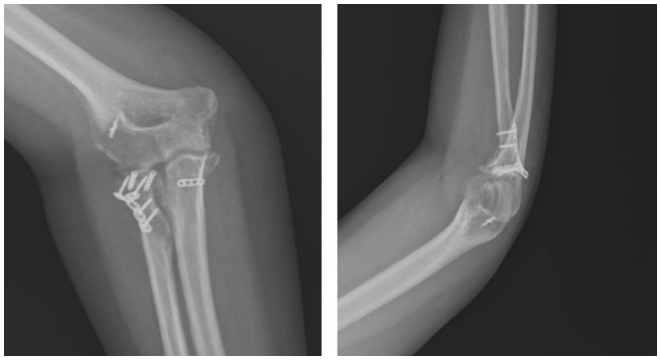

Figure 2. Radial head fixation with plate-screw, coronoid fixation with endobutton, LCL repair with anchor.

Figure 3. Radial head fixation with screw, coronoid fixation with endobutton, LCL repair with anchor.

Complications such as union problems, nerve damage, and infection were recorded during follow-up. Alignment of the humeroulnar and humeroradial joints and arthritic changes were evaluated.

Statistical Analysis

Demographic and clinical data of the patients were analyzed using descriptive statistics. Mean, standard deviation, minimum, and maximum values were calculated for continuous variables, whereas categorical variables were expressed as percentage distributions. The Shapiro–Wilk test was used to check the distribution of the elbow ROM and radiographic assessment data. Arthritis stages according to the Broberg and Morrey classification were reported as percentages. Mean MEPS and DASH scores were calculated. Complication rates were presented as percentages, and significance levels were tested by Chi-squared or Fisher's exact test. A value of $p<0.05$ was accepted as the statistical significance criterion in the analyses.

RESULTS

The mean follow-up period was 23.2 months (range: 18–32 months). The mean age of the patients was 43.8 years (range: 32–60). Of the 10 patients included in the study, three were female and seven were male. At the last follow-up, the mean flexion and extension ROM was 120° (range: 90°–140°) and the mean pronation and supination ROM was 140° (range: 60°–180°). No instability or discomfort was reported by any patient postoperatively (Table 1).

The mechanisms of injury were as follows: Two patients had a road traffic accident, six patients had a motorcycle accident, and the remaining two patients had a fall from a height.

Four patients had isolated elbow injuries, and six patients had additional injuries. Five patients had injuries on the dominant side and five on the non-dominant side. Pre-operative imaging consisted of bilateral elbow radiographs and computed tomography (CT) scans. Two patients developed pre-operative radial nerve injury, and one patient developed post-operative posterior interosseous nerve (PIS) injury. One patient had an open type 1 fracture.

Table 1. Patient characteristics and follow-up data

Mean follow-up period	23.2 months (range: 18–32 months)
Mean age of the patients	43.8 years (range: 32–60)
Ten patients were included in the study	3 (female), 7 (male)
Mean flexion and extension range of motion	120° (range: 90°–140°)
Mean pronation and supination range of motion	140° (range: 60°–180°).
Mayo Elbow Performance score	90 points (range: 80–100)
Disabilities of the Arm, Shoulder, and Hand	8–20
The mechanisms of injury	Two patients had a road traffic accident
	Six patients had a motorcycle accident
	Two patients had a fall from a height
Isolated elbow injuries	Four patients
Additional injuries	Six patients
Injuries on the dominant side	Five patients
Injuries on the non-dominant side	Five patients

During the evaluation process, elbow ROM, and humeroulnar and humeroradial joint distances were analyzed on antero-posterior and lateral radiographs. The Broberg and Morrey classification was used to assess the presence of arthritis. After at least 18 months of follow-up, no patient had stage 3 arthritis, three patients had stage 2 arthritis, and seven patients had stage 1 arthritis. The MEPS was calculated, and a mean score of 90 points (range: 80–100) was obtained for the entire cohort. Five patients achieved a MEPS score of 90 or higher, which is considered an excellent outcome.

Patients completed the 30-item DASH questionnaire, which assesses activities of daily living, upper extremity pain, and paresthesias. DASH scores ranged from 8 to 20.

No ulnar nerve pathology, elbow stiffness, radioulnar synostosis, joint dislocation, ulnar nerve impingement syndrome, instability, delayed union, subluxation, or heterotopic ossification complications were observed during post-operative follow-up. None of the patients required revision surgery. One patient developed post-operative PIN injury; this nerve showed signs of regeneration in the 1st month. Two patients had serous drainage at the wound site, which was successfully managed with serial dressings. Two patients had pre-operative radial nerve palsy, one of whom showed signs of nerve regeneration at 3 weeks postoperatively. Tendon transfer surgery was planned for the other patient with persistent nerve palsy.

DISCUSSION

In our study, the mean ROM for flexion and extension at the final follow-up was 120° (range: 90°–140°), whereas the mean ROM for pronation and supination was 140° (range: 60°–180°). No patients reported instability in either the early or late post-operative period. After a minimum follow-up of 18 months, no patients exhibited grade 3 arthritis, whereas three patients had grade 2 arthritis and seven patients had grade 1 arthritis. The MEPS was calculated, with a mean score of 90 (range: 80–100) across the entire cohort. Five patients achieved a MEPS score of 90 or higher, indicating excellent outcomes. The DASH questionnaire, which evaluates daily living activities, upper extremity pain, and paresthesia, revealed DASH scores ranging from 8 to 20.

Dislocations of the elbow are not common injuries and should be considered TTEI unless proven otherwise. After reduction, a CT scan should be performed to evaluate associated bone lesions.[11] In their study, Giannicola et al.[12] found that the ROM, MEPS, and DASH scores of the patients they analyzed were similar to our patients, but the post-operative complication rates, secondary osteoarthritis rates, and number of patients requiring revision were high. In a systematic review by Chen et al.,[13] both MEPS and DASH scores were found to be worse than the rates in our study. They also found the post-operative complication rate to be quite high. While heterotrophic ossification was not found in any of our patients, Chen et al.[13] found 12.5% heterotopic ossification in their study.

The management of coronoid tip fractures, which is an important component of TTEI injuries, is controversial.[14,15] The main aim of coronoid fixation is not to repair the ligament but to re-tension the anterior capsule. Tullos et al.[15] in 1981 mentioned the importance of the coronoid process in elbow stability. Subsequently, new classification systems related to

coronoid fractures were developed following the increase in studies in the literature related to the role of the coronoid in elbow stability. The study by Morrey and Regan is an important step at this point. They proposed a classification based on coronoid height and defined the categories of avulsion type (type I), <50% involvement (type II), and >50% involvement (type III). They also recommended fixation of type III coronoid fractures in their study.[5] O'Driscoll et al.[16] classified coronoid fractures according to size and anatomical location. In their study, they found that involvement of <2 mm usually did not require internal fixation. Another study on coronoid fractures was performed by Jeon et al.,[17] who reported that apical and mid-transverse fractures involving <50% of the coronoid height may not require fixation if the LCL and radial head are intact. In addition, it has been highlighted in the literature that the coronoid process is an important stabilizer for varus and internal rotation of the elbow.[18] We hypothesized that the clinical significance of coronoid fractures would depend not only on fracture size, displacement, or location, but also on damage to the anterior capsule, a critical structure for elbow stability. The results of this study support this hypothesis. We suggest that endobutton repair of the anterior capsule may improve stability, particularly in patients with capsular avulsion.

Recent studies have shown that MCL injury rates are high in patients with TTEI.[19] Although it has been suggested that MCL repair may prevent post-traumatic osteoarthritis (PTOA), long-term data on MCL repair after TTEI are still lacking.[20] Contrary to the literature, we did not perform MCL repair in any of our patients. We believe that PTOA is associated with anterior capsular stability. We conclude that anterior capsulodesis has a beneficial effect on long-term elbow function scores.

Surgical protocols for TTEI are not yet universally standardized. This study suggests that a single lateral incision is sufficient for TTEI and that the coronoid process should be fixed with the endobutton system regardless of its size or the site of fracture or rupture.

In our study, elbow stability in TTEI patients with coronoid fractures classified as O'Driscoll type I and II, Regan–Morrey type I and II was achieved with LCL repair, radial head fixation, and anterior capsulodesis. Anterior capsule fixation was performed with the endobutton system using transosseous tunnels. This approach resulted in improved DASH and Mayo Elbow scores compared to the literature. It also reduced the incidence of PTOA.

Limitations

This study has several limitations. First, its retrospective design poses challenges in establishing causality. In addition, the limited sample size, absence of a control group, and long-term follow-up constraints reduce the generalizability of the findings. Furthermore, uncertainties remain regarding the long-term effects of anterior capsulodesis. These limitations highlight the need for further research involving larger patient populations to provide more robust evidence.

CONCLUSION

This study demonstrates that endobutton fixation of O'Driscoll and Regan–Morrey type I-II coronoid fractures in the treatment of TTEI has a positive impact on elbow function in the mid-to-long term. The favorable outcomes of clinical functional assessment parameters following major injuries, such as TTEI, along with the successful results of osteoarthritis staging systems, are key findings that highlight the efficacy of anterior capsulodesis. This suggests that anterior capsulodesis may be a noteworthy treatment option in clinical practice. However, to optimize treatment protocols and comprehensively evaluate long-term outcomes in the management of TTEI, larger-scale, prospective, randomized controlled trials are warranted.

DECLARATIONS

Ethics Committee Approval: The study was approved by Antalya Training and Research Hospital Medical Research Scientific Ethics Committee (No: 19/27, Date: 05/12/2024).

Informed Consent: : Due to the retrospective nature of the study, the requirement for informed consent was waived by the institutional ethics committee.

Conflict of Interest: The authors declare that there is no conflict of interest.

Funding: No funds have been received for this study.

Use of AI for Writing Assistance: Not declared.

Authorship Contributions: Concept – CA; Design – CA; Supervision – CA; Fundings – CA; Materials – HM; Data collection &/or processing – HK; Analysis and/or interpretation – CA; Literature search – BA; Writing – CA; Critical review – CA.

Peer-review: Externally peer-reviewed.

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