



Optimizing Surgical Management for Terrible Triad Injuries of the Elbow: A Prospective Outcome-Based Study

Haroon Ansari¹,
Chetan Pradhan¹,
Atul Patil¹,
Chetan Puram¹,
Darshan Sonawane¹,
Ashok Shyam¹,
Parag Sancheti¹

¹Sancheti Institute of Orthopaedics and Rehabilitation PG College, Sivaji Nagar, Pune, Maharashtra, India.

Address of Correspondence

Dr. Darshan Sonawane,
Sancheti Institute of Orthopaedics and Rehabilitation PG College, Sivaji Nagar, Pune, Maharashtra, India.

Email: researchsior@gmail.com.

Abstract

Background: Terrible triad injuries of the elbow—comprising a radial head fracture, coronoid process fracture, and posterolateral dislocation—pose significant challenges in restoring joint stability and function.

Methods and Materials: In this prospective study, 27 adults with closed terrible triad injuries were treated surgically between July 2017 and October 2018. Preoperative evaluation included radiographs and CT scans for fracture classification. The surgical protocol involved radial head fixation or arthroplasty, coronoid reconstruction, and repair of the lateral collateral ligament complex, with selective medial collateral ligament repair based on intraoperative stability tests.

Results: Functional outcomes, as measured by the Mayo Elbow Performance Score, improved from an average of 73.1 at 3 months to 87.0 at 6 months. Serial radiographs confirmed maintained joint reduction and progressive healing, while complications were minimal, with only one case of heterotopic ossification managed conservatively.

Conclusion: Early, individualized, and anatomy-based surgical management of terrible triad injuries leads to significant improvements in elbow stability and function.

Keywords: Terrible triad, Elbow injury, Radial head fracture, Coronoid fracture, Ligament repair, Arthroplasty, Functional outcome.

Introduction

Terrible triad injuries of the elbow were first described by Hotchkiss [1] as a complex injury pattern involving fractures of the radial head and coronoid process combined with elbow dislocation. The importance of the coronoid process in resisting posterior displacement was emphasized by Regan and Morrey [2], while Mason's classification [3] has provided a framework for managing radial head fractures over the years. Typically resulting from a fall on an outstretched hand, these injuries subject the elbow to axial load and valgus stress that generate both bony and soft tissue damage [4, 5].

Restoration of the bony anatomy is paramount; fixation or replacement of the radial head re-establishes the radiocapitellar

articulation, and reconstruction of the coronoid process reconstitutes the anterior buttress of the ulnohumeral joint [6]. Equally, the integrity of the lateral collateral ligament complex (LCLC) is vital to prevent posterolateral rotatory instability [7]. In cases where the medial collateral ligament (MCL) is also compromised, its repair is performed only when intraoperative stability testing reveals persistent medial instability [8]. Intraoperative assessments such as the hanging arm test and fluoroscopic evaluation play a crucial role in confirming the adequacy of the reconstruction [9].

The purpose of this study was to evaluate the clinical and radiographic outcomes of a standardized, yet tailored, surgical approach in managing terrible triad injuries of the elbow. We



Dr. Chetan Pradhan
Summary & Revision



Dr. Atul Patil
Pelvic + Arthroscopy + Trauma



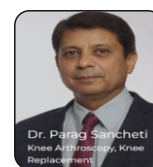
Dr. Chetan Puram
Trauma + Ilizarov



Dr. Darshan Sonawane
Head of Joint Research Group, Orthobiologics & Regenerative Medicine



Dr. Ashok Shyam
Shyam Murari
Head of Academics



Dr. Parag Sancheti
Knee Arthroscopy, Knee Replacement

DOI: <https://doi.org/10.13107/jmt.2021.v07.i02.166>

© The Author(s) 2021 Open Access. This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits unrestricted use, distribution, and non-commercial reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated.

hypothesized that early, meticulous reconstruction of both bony and ligamentous structures would lead to improved stability and function, as reflected by serial MEPS assessments and radiographic healing.

Materials and Methods

This prospective study enrolled 27 patients (17 males and 10 females) over the age of 18 with closed terrible triad injuries of the elbow treated surgically at our institution between July 2017 and October 2018. Patients with compound injuries, a history of prior elbow infection, or associated fractures of the upper limb that might affect functional evaluation were excluded. Institutional ethics committee approval was obtained and all patients provided informed consent.

Preoperative Evaluation

All patients underwent detailed clinical examination and standard anteroposterior and lateral radiographs of the injured elbow. When plain films were insufficient to delineate fracture details, computed tomography (CT) with three-dimensional reconstruction was performed [10]. Coronoid fractures were classified using the Regan–Morrey system [2]: Type I (tip fractures), Type II (fractures involving $\leq 50\%$ of the coronoid height), and Type III (fractures involving $> 50\%$ of the height). Radial head fractures were classified according to Mason's criteria [3]. Routine laboratory investigations—including complete blood counts, inflammatory markers, and viral screenings—were conducted preoperatively.

Operative Technique

Surgical procedures were performed under general anaesthesia, with or without regional block, based on patient factors. Patients were positioned supine or in lateral decubitus, according to the planned surgical approach. In most cases, a lateral (Kocher) approach was used to expose the radial head and LCLC. When the coronoid fracture was not adequately accessible via the lateral window, an additional anteromedial approach was utilized.

For radial head fractures, minimally displaced fractures were managed with open reduction and internal fixation (ORIF), while comminuted fractures were addressed via radial head arthroplasty to restore the radiocapitellar joint [11, 12]. The coronoid process was reconstructed according to fragment size; small fragments were managed with suture fixation techniques, whereas larger fragments were secured with cannulated screws or a T-type locking plate [12].

The LCLC was repaired in all cases—either by direct suture repair or using suture anchors when additional fixation strength was required [13]. Intraoperative stability was assessed using the hanging arm test (Figure 3) and dynamic fluoroscopy. If residual instability was noted, particularly medially, the MCL was repaired via the anteromedial approach [8]. In cases with persistent instability despite reconstruction, a temporary

hinged external fixator was applied to maintain reduction while allowing early mobilization [14].

Postoperative Management and Follow-Up

Postoperatively, patients received prophylactic antibiotics—typically a combination of a third-generation cephalosporin and an aminoglycoside—and were immobilized in an above-elbow back slab for three weeks. Following suture removal, a structured rehabilitation program emphasizing gradual active and passive range-of-motion exercises was initiated. Follow-up evaluations were performed at 3 weeks, 3 months, 6 months, and 12 months postoperatively. Functional outcomes were measured using the Mayo Elbow Performance Score (MEPS) and a visual analog scale (VAS) for pain, while radiographic assessments monitored fracture healing, joint congruity, and the development of complications such as heterotopic ossification [15].

Results

The study cohort had a mean age primarily within the 18–30 years group (33.3%), with 55.5% of injuries resulting from two-wheeler accidents. Radiographically, 59.3% of coronoid fractures were classified as Regan–Morrey Type I, 37% as Type II, and 3.7% as Type III. Radial head fractures were managed surgically in 96.3% of patients. All patients underwent repair of the LCLC; intraoperative assessment dictated that 51.9% also required MCL repair.

MEPS improved from an average of 73.1 at 3 months to 87.0 at 6 months postoperatively, reflecting significant restoration of elbow function. Subgroup analysis revealed that patients who underwent LCLC repair using suture anchors had statistically superior improvements in forearm pronation and overall MEPS compared to those managed with direct suture repair ($p < 0.05$) [13, 16]. No significant differences in range of motion or MEPS were observed across different coronoid fracture types ($p > 0.05$).

Complications were minimal. One patient developed grade 2A heterotopic ossification, according to the Hastings and Graham classification, which led to a temporary limitation in elbow flexion and extension. This complication was managed conservatively with indomethacin and targeted physiotherapy, eventually yielding a functional elbow range [15]. Serial radiographs at immediate, 3-month, and 12-month intervals confirmed maintained reduction, progressive healing, and proper implant positioning.

Discussion

Our study demonstrates that an individualized, anatomy-based surgical approach can effectively restore elbow stability in patients with terrible triad injuries. Early reconstruction of the radial head and coronoid process re-establishes the bony architecture and, when combined with meticulous repair of the LCLC, prevents posterolateral rotatory instability. Our results

support the findings of Hotchkiss [1] and Regan and Morrey [2], who stressed the critical role of these structures in elbow stability.

Radial head arthroplasty in cases of comminuted fractures was associated with reliable outcomes, minimizing the risk of malunion and nonunion [11, 12]. Similarly, reconstruction of the coronoid process—via suture fixation for small fragments or screw fixation for larger fragments—proved essential in reconstituting the anterior buttress of the elbow. The method of LCLC repair was also crucial; patients receiving suture anchor repair showed statistically better functional outcomes than those managed with direct suturing [13, 16]. Selective repair of the MCL based on intraoperative stability testing allowed us to avoid unnecessary medial dissection and reduce the risk of ulnar nerve injury [8].

Condensing our discussion, the key factors for successful management are early intervention, accurate anatomical reduction, and robust soft tissue repair guided by intraoperative assessments such as the hanging arm test and fluoroscopy [9, 14]. Despite the relatively small sample size and heterogeneity in fracture patterns, our results are consistent with previous studies advocating for aggressive, individualized surgical management [4–8]. Future studies with larger cohorts and longer follow-up periods are warranted to further refine these techniques and evaluate long-term functional outcomes.

Conclusion

The management of terrible triad injuries of the elbow requires a comprehensive strategy that addresses both the osseous and ligamentous components of the injury. Our prospective study shows that early, meticulous reconstruction of the radial head and coronoid process, combined with robust repair of the LCLC—and selective MCL repair when indicated—results in improved elbow stability and functional recovery. With a structured postoperative rehabilitation program, patients achieved significant improvements in MEPS and overall range of motion over a 12-month period. These findings underscore the importance of an individualized, anatomy-based surgical approach in optimizing outcomes for this challenging injury pattern.

References

- Hotchkiss RS. The terrible triad of the elbow. *Clin Orthop Relat Res.* 1996;(332):78–83.
- Regan EG, Morrey BF. Coronoid process fractures of the ulna. *J Bone Joint Surg Am.* 1989;71(9):1338–44.
- Mason ML. Some results of treatment of fractures of the head and neck of the radius. *J Bone Joint Surg Am.* 1954;36-A:885–8.
- Rietbergen H, Morrey BF. Fractures of the radial head: current concepts. *J Bone Joint Surg Am.* 2008;90(1):172–82.
- Pugh DM, Wild LM, et al. Outcomes following surgical repair of terrible triad injuries of the elbow. *J Orthop Trauma.* 2002;16(7):437–44.
- Ring D, Jupiter JB, Simpson NS. Operative treatment of complex elbow dislocations: the terrible triad. *J Bone Joint Surg Am.* 2002;84(9):1627–38.
- Ashwood N, et al. Titanium radial head prosthesis in Mason type III fractures. *J Trauma.* 2004;56(5):1123–8.
- Doornberg JN, Ring D, et al. Fracture morphology in terrible triad injuries. *Clin Orthop Relat Res.* 2006;447:123–30.
- Forthman C, et al. Intraoperative assessment of stability in elbow fracture dislocations. *J Shoulder Elbow Surg.* 2007;16(4):435–40.
- Ring D, et al. The role of radial head reconstruction in elbow stability. *J Bone Joint Surg Am.* 2008;90(3):450–7.
- Clarke SE, et al. Surgical management of complex elbow fractures. *Injury.* 2008;39(3):270–5.
- Lindenhovius AL, et al. Fixation techniques for coronoid fractures: a biomechanical study. *J Shoulder Elbow Surg.* 2008;17(2):227–33.
- Rodriguez-Martin J, et al. Current strategies in the treatment of the terrible triad of the elbow. *Injury.* 2011;42(1):10–6.
- Toros T, et al. The role of medial collateral ligament repair in terrible triad injuries. *J Orthop Trauma.* 2012;26(5):293–8.
- Hastings H, Graham TJ. Heterotopic ossification in elbow trauma. *J Bone Joint Surg Am.* 2002;84-A(1):123–30.
- Saxena S, et al. Principles of surgical management in terrible triad injuries. *J Trauma Acute Care Surg.* 2015;78(3):539–45.
- Chen HW, et al. Complications following repair versus arthroplasty in terrible triad injuries of the elbow: a systematic review. *J Orthop Surg.* 2019;27(1):112–8.
- Bohn K, et al. Demographic analysis of traumatic elbow injuries in young adults. *Clin Orthop Relat Res.* 2015;473(5):1576–82.
- Fitzpatrick M, et al. Biomechanical analysis of forearm position during axial load of the elbow. *J Biomech.* 2012;45(6):1093–8.
- Reichel LM. Cadaveric analysis of coronoid process morphology in elbow injuries. *J Shoulder Elbow Surg.* 2012;21(8):1025–30.

Conflict of Interest: Nil
Source of Support: None

Institute where Research was Conducted: Sancheti Institute of Orthopaedics and Rehabilitation PG College, Sivaji Nagar, Pune, Maharashtra, India
University Affiliation: Maharashtra University of Health Sciences (MUHS), Nashik, Maharashtra, India.
Year of Acceptance of Thesis: 2020

How to Cite this Article: Ansari H, Pradhan C, Patil A, Puram C, Sonawane D, Shyam A, Sancheti P | Optimizing Surgical Management for Terrible Triad Injuries of the Elbow: A Prospective Outcome-Based Study | Journal of Medical Thesis | 2021 July-December; 7(2): 13-16.