

Research Article:

Comparison of Radial Head Resection With Radial Head Fixation in the Terrible Triad Injury of the Elbow



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Citation Najd Mazhar F, Shariatzadeh H, Sadony H, Bagheri N, Ebrahimi H. Comparison of Radial Head Resection With Radial Head Fixation in the Terrible Triad Injury of the Elbow. Journal of Research in Orthopedic Science. 2019; 6(4):19-24. <http://dx.doi.org/10.32598/JROSJ.6.4.61>

<http://dx.doi.org/10.32598/JROSJ.6.4.61>



Article info:

Received: 16 May 2019

Revised: 10 Jun 2019

Accepted: 25 Sep 2019

Available Online: 01 Nov 2019

Keywords:

Terrible triad, Radial head, Resection, Fixation

ABSTRACT

Background: The optimal treatment of radial head component in the terrible triad injuries of the elbow is challenging. In this study, we compared the functional outcome and complication rates of radial head resection with radial head fixation in a terrible triad setting.

Objectives: Comparison of radial head resection with radial head fixation in terrible triad.

Methods: In the present retrospective study, the outcome of terrible triad injury in 41 patients, in whom the radial head component was managed with either radial head resection (n=28) or open reduction and internal fixation (n=13), was compared. The subjective assessments of the outcome included Visual Analog Scale (VAS) for pain, the Mayo Elbow Performance Score (MEPS), and the Disabilities of the Arm, Shoulder, and Hand (DASH) score. The objective assessment of outcome included the evaluation of elbow Range of Motion (ROM) and elbow stability.

Results: The Mean±SD age of the patients was 39.2±10.2 years. The demographic characteristics of the patients of the two study groups were not statistically different. The mean supination/pronation arc of motion was not significantly different between the two study groups (P=0.11). The mean flexion/extension arc of motion was significantly more in the fixation group (P=0.001). The mean MEPS and DASH scores were not significantly different between the study groups (P=0.22 and P=0.49, respectively). The mean VAS was significantly more in the fixation group (P=0.04). All the elbows were stable at the last follow-up. The postoperative complications (arthrosis and heterotopic ossification) were considerably more in the resection group.

Conclusion: Although comparable at function, the present study favors the radial head fixation whenever possible to avoid the postoperative complications of radial head reaction.

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1. Introduction

Elbow injury is associated with a wide range of pathologies [1]. The “terrible triad” term is referred to the fracture-dislocations of the elbow with 3 concurrent injuries: posterior elbow dislocation, coronoid process fracture, and radial head fracture [2, 3]. It is one of the most complex injuries of the elbow, and the outcome has been historically poor with several post-treatment complications such as persistent pain, posttraumatic arthrosis, contractures, instability, and functional limitations [4]. Even so, recent therapeutic advances in the management of terrible triad have demonstrated more promising results than the previous studies [5-7].

The radial head component of the terrible triad has been traditionally addressed with arthroplasty or Open Reduction and Internal Fixation (ORIF) depending on the severity of the comminution [8]. The radial head replacement can result in similar elbow stability and overall outcomes compared to radial head repair [9]. Recently, radial head resection has been introduced as a substitute for the radial head prosthesis in the management of severely-comminuted radial head in a terrible triad setting and has shown to provide similar results to arthroplasty [10]. However, no study has been performed to compare the results of radial head resection with radial head fixation.

In this study, we aimed at comparing the functional outcome and complication rates of radial head resection with radial head fixation in a cohort of patients with terrible triad injury of the elbow.

2. Methods

The review board approved this survey of our institute. Written informed consent was obtained from the patients to use their medical data for publication. In a retrospective study, patients who were referred to our center with a terrible triad injury of the elbow between 2010 and 2015 and their radial head fractures were treated with either resection or ORIF, were evaluated for eligibility to include in the current study. Patients would be excluded if they were not available for the final assessment (6 patients) or did not follow the postoperative protocol (2 patients). Patients with a follow-up of fewer than 6 months were excluded from the study, as well (2 patients). The radial head was treated with ORIF in 13 patients and with resection in 28 patients. A subset of the study popu-

lation in the resection group was already presented in another context [10].

We used the Regan-Morrey system for the classification of coronoid fractures and Mason system for the classification of radial head fractures [11, 12]. The functional outcome was assessed subjectively, using a Visual Analog Scale (VAS) for pain, the Mayo Elbow Performance Score (MEPS), and the Disabilities of the Arm, Shoulder, and Hand (DASH) score [13, 14]. The functional outcome was also evaluated objectively, using the evaluation of elbow Range of Motion (ROM) (supination, pronation, extension, and flexion) and chair-raise test of stability [15]. The subjective and objective assessments were done by investigators who were blinded to the type of treatment.

For the assessment of radiographic outcome, standard anteroposterior and lateral radiographs were obtained in the last evaluation session. The radiographic evaluation of outcome included the assessment of union (monitoring the bony callus formation), humeroulnar arthrosis (Broberg and Morrey classification), Heterotopic Ossification (HO) according to Hastings and Graham, and synostosis [16, 17]. The radiographic assessments were done by a musculoskeletal radiologist and a hand surgeon, who was not involved in the study.

Surgical procedures

After the primary closed reduction performed at our or other centers, the arm was immobilized in a dorsal long arm splint until the date of operation. Before the operation, the injury pattern was evaluated using plain radiographs and computed tomography scans.

In the operation theater, under the general anesthesia, the patients were positioned at the supine position. Then, an upper-arm pneumatic tourniquet was applied. Through the lateral Kocher approach, the coronoid fracture was managed first, using transosseous fixation with a FiberWire suture No 2. Large coronoid fractures were treated with ORIF through a medial approach.

The severely-comminuted radial head fractures were managed with resection. After the resection of the radial head, a pull test was used to ensure the absence of the Essex-Lopresti [18]. In this respect, the migration of more than 6 mm under a proximal force of 90 N was considered to the presence of interosseous membrane injury and Essex-Lopresti lesion. No positive pull test was noticed at this step. The medial collateral ligament was repaired in all patients who were treated with radial head resection to prevent valgus instability. At the end of

the operation, the fluoroscopy and plain portable radiographs were obtained to check the quality of the reduction and stability of the elbow. The clinical stability was checked on the operating table, using varus/valgus stress and gravity test [19].

Radial head fractures would be treated with ORIF if not severely comminuted. In this respect, countersunk small-fragment screws or headless compressions screws were used for the fixation of Mason II fractures, while modular plates were used for the fixation of Mason III fractures. If the elbow instability was not resolved at this point, the surgeon would proceed to repair the medial collateral ligament, using a heavy braided nonabsorbable suture.

Postoperative protocol

Postoperatively, the patients' elbows were immobilized in a long arm splint in 90° flexion and neutral forearm rotation for 1 week. At this period, intermittent active ROM exercise was initiated from 90° up to full flexion as tolerated. The splint was removed at the end of the second week, and physical therapy was started for active ROM. The extension was planned to be extended by 10° per week.

Statistical analysis

All the statistical evaluations were performed in SPSS V. 16 for Windows. Descriptive statistics were provided as Mean±SD or number and percentage. A comparison of the mean values between the two study groups was performed with the independent-samples t-test or its nonparametric equivalent (Mann-Whitney U test). Association between qualitative variables was calculated with the Chi-squared test. The P<0.05 was considered as significance level.

3. Results

The outcome of 41 patients with terrible triad injury of the elbow was evaluated in this study. The Mean±SD age of the patients was 39.2±10.2 years. Falling was the most frequent cause of injury (35 patients), followed by motor vehicle accidents (4 patients). The radial head fracture was resected in 28 patients and managed with ORIF in 13 patients. The associate injury was present in 11 patients of the resection group and 1 case of the ORIF group (P=0.039). No other significant difference was observed between the characteristic features of the two study groups (Table 1).

The mean supination/pronation arc of motion was not significantly different between the two study groups

Table 1. The clinical and demographic characteristics of the patients of the two study groups

| Variable | Mean±SD | | Sig. | |
|---|------------------------|-------------------|-----------|------|
| | Resection Group (n=28) | ORIF Group (n=13) | | |
| Age (y) | 39.9±10.2 | 37.6±9.8 | 0.44 | |
| Delay to operation (d) | 7.4±9.3 | 6.7±5.8 | 0.21 | |
| Follow-up (mo) | 22.7±12.1 | 22.9±18 | 0.78 | |
| Variable | No. (%) | | Sig. | |
| | Resection Group (n=28) | ORIF Group (n=13) | | |
| Gender | Female | 10 (35.7) | 4 (30.8) | 0.6 |
| | Male | 18 (64.3) | 9 (69.2) | |
| Hand dominance | Dominant | 16 (57.1) | 7 (53.8) | 0.59 |
| | Non-dominant | 12 (42.9) | 6 (46.2) | |
| Type of coronoid injury (Regan-Morrey classification) | I | 18 (64.3) | 8 (61.5) | 0.35 |
| | II | 10 (35.7) | 5 (38.5) | |
| Type of radial head injury (Masson classification) | II | 2 (7.1) | 1 (7.7) | 0.97 |
| | III | 26 (92.9) | 12 (92.3) | |

Table 2. Comparison of the outcome measures between the two study groups

| Variable | Mean±SD | | Sig. |
|------------------------------|------------------------|-------------------|-------|
| | Resection Group (n=28) | ORIF Group (n=13) | |
| Flexion/extension ROM (°) | 149±17 | 158±16 | 0.001 |
| Supination/pronation ROM (°) | 110±52 | 114±26.4 | 0.11 |
| DASH | 9.6±7 | 10±8.1 | 0.19 |
| VAS | 1.8±0.9 | 2.4±1.1 | 0.04 |
| MEPS | 92.1±9.6 | 90.3±9.7 | 0.32 |

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ROM: Range of Motion; DASH: Disabilities of Arm, Shoulder, and Hand; VAS: Visual Analog Scale; MEPS: Mayo ELbow Performance Score

($P=0.11$). The mean flexion/extension arc of motion was significantly different between the two study groups ($P=0.001$). The mean MEPS and DASH scores were not significantly different between the study groups ($P=0.22$ and $P=0.49$, respectively). Also, the mean VAS of the patients was significantly more in the ORIF group ($P=0.04$). [Table 2](#) presents the outcome measures of the two study groups.

Postoperative complications

At the final evaluation session, the elbow was stable in all patients, and the bony union was detectable. The Essex-Lopresti injury was seen in none of the patients. Synostosis of the proximal radius and ulna was observed in 1 patient of the resection group and no patient in the ORIF group. HO type I was recorded in 1 patient of the ORIF group and 7 patients of the resection group. HO type II was seen in 1 patient of the resection group and no patient of the ORIF group. This patient underwent elbow release operation 13 months after the primary operation, and indomethacin was prescribed afterward. Posttraumatic osteoarthritis was observed in 7 patients of the resection group and 1 patient of the ORIF group. Two patients in the resection group reported wrist pain. Radial migration was not noticed at the radiologic evaluation of these patients. Consequently, the wrist pain was managed with physiotherapy.

4. Discussion

In this study, we compared the outcome of radial head resection with ORIF operation in the treatment of the radial head component of terrible triad injury. Based on the results of this study, both radial head resection and ORIF provided an acceptable subjective functional outcome. However, the flexion/extension arc of motion was significantly lower in

radial head resection. Besides, the rate of postoperative complications, particularly HO and traumatic osteoarthritis, was considerably more in radial head resection. On the other hand, the postoperative pain was significantly more in patients who underwent ORIF operation.

Watters et al. compared the outcome of terrible triad injuries of the elbow in patients whose radial head fractures were treated with either ORIF ($n=9$) or radial head arthroplasty ($n=30$). There was no significant difference between ROM or elbow scores (DASH) of the two study groups.

At the final follow-up, the elbow was unstable in 3 patients (33.3%) of the ORIF group and no patient of the arthroplasty group. On the other hand, 11 patients (36.6%) of the arthroplasty group and no patient of the ORIF group demonstrated radiographic signs of posttraumatic arthrosis. The reoperation rate was not significantly different between the groups. They concluded that radial head arthroplasty provides comparable overall outcomes compared to ORIF in the treatment of radial head fracture of terrible triad injury [9]. Similar to the results of the present study, radial head prosthesis contains some advantages and some disadvantages over the ORIF. Instability was reported as one of the main complications in the study of Watters et al. However, all elbows, which were treated with ORIF in our research, were stable at the last follow-up.

Leigh and Ball also compared the outcome of radial head reconstruction ($n=13$) and replacement ($n=11$) in the treatment of terrible triad injuries of the elbow. Based on their results, no significant difference was observed between American shoulder and elbow surgeons score, satisfaction score, ROM, and the associated arc of motion of the two study groups. A statistically slight significant advantage in terms of DASH scores was seen in

the arthroplasty group, which was acknowledged by the authors as clinically negligible.

No elbow instability was recorded in any of the patients. In spite of comparable results between the two study groups, in their conclusion, the authors favored radial head repair over arthroplasty because of the increased complications and reoperation rate in the arthroplasty group [20].

The study of Najd Mazhar et al. is the first and only study reporting the outcome of radial head resection as a choice of treatment in the management of radial head component in terrible triad injury. They compared the results of radial head resection (n=29) with prosthetic arthroplasty (n=15) in the treatment of severely comminuted radial heads in terrible triad injury. The mean ROM, VAS, DASH score, and MEPS of the two study groups were not statistically different. The elbow was stable in all patients at the final visit. The Essex-Lopresti injury was not developed in any of the patients. Post-traumatic osteoarthritis was observed in 8 patients of the resection group and 5 patients of the arthroplasty group. They concluded that radial head resection and replacement provide comparable results in terrible triad injury [10].

The present study was the first study to compare the results of radial head resection and repair in a terrible triad setting. The results of this study revealed that radial head resection could provide a comparable function to radial head repair. Elbow instability was not a concern, as reported following the repair of the radial head in the study of Watters et al. [4]. The flexion/extension arc of motion was slightly better in the repair group, while the postoperative pain level was slightly more in this group. However, similar to the study of Leigh and Ball, we suggest using radial head repair whenever possible, particularly in young and active patients, to prevent the complications of radial head resection.

Although the available studies state that radial head resection, repair, and arthroplasty can yield the same functional outcome in terrible triad injuries, their results could be confounded by the level of comminution and number of associated injuries. For example, 11 patients in the resection group of the study had associated injuries versus 1 patient in the repair group. Therefore, the optimum comparison of these techniques with radial head repair would only be possible if the patients were matched for the level of comminution and the number of associated injuries.

The present study was not without limitations. The main limitation of the study was the retrospective nature of the investigation. Therefore, prospective well-controlled studies are needed to define the optimum surgical algorithm for terrible triad injury conclusively.

5. Conclusion

Radial head resection provides a comparable function to radial head fixation in the terrible triad setting. While the postoperative ROM was slightly more in radial head repair, the postoperative pain was somewhat less in radial head resection. The postoperative complications, particularly posttraumatic arthrosis and HO, were remarkably more in the resection group. These results favor performing radial head repair, whenever possible, to avoid the postoperative complications of radial head reaction.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles were considered in this article and all data used by patients permission.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

Methodology: Farid Najd Mazhar; Sampling, editing: Hooman Shariatzadeh; Writer, editor: Hanon Sadony; Reviewer: Nima Bagheri; Editor: Hojatollah Ebrahimi.

Conflict of interest

The authors declared no conflict of interest.

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