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Radial head reconstruction versus replacement in the treatment of terrible triad injuries of the elbow

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Introduction: Dislocation of the elbow with associated fractures of the radial head and the coronoid process of the ulna have been referred to as the terrible triad of the elbow because of the difficulties in treating this injury and the poor outcomes.

Materials and methods: There were 23 patients (24 elbows) available for evaluation with this injury during a 7-year period at Auckland City Hospital.

Results: There were 11 women and 12 men with an average age of 43.5 years. The mean duration of follow-up was 41 months. The mean range of flexion was 135° (range, 110°-145°), extension was 8° (range, 0°-40°), supination was 75° (range, 15°-85°), and pronation was 80° (range, 20°-90°). No patients reported ongoing symptoms of instability. We compared the radial head repair group (13 patients) and the radial head replacement group (11 patients), which showed no significant difference between the variables of age, length of follow-up, American Shoulder and Elbow Surgeons score, satisfaction score, range of motion (flexion, extension, supination, pronation), and the associated arcs of motion. Only one significant difference was noted: the radial head replacement group scored higher values on the Disabilities of Arm, Shoulder, and Hand assessment.

Conclusions: Elbow fracture-dislocations are difficult injuries to treat. Our study shows that with operative repair or replacement of the radial head to restore stability through radiocapitellar contact, coronoid, and lateral ligament repair, good range of movement and stability can be achieved at short-term follow-up.

Level of evidence: Level III, Retrospective Case Control Design, Treatment Study.

Keywords: Elbow; terrible triad injuries; radial head repair; radial head replacement

Dislocations of the elbow with associated fractures of the radial head and the coronoid process of the ulna have been referred to as terrible triad injuries because of difficulties in treatment and poor reported outcomes (Fig. 1).[1,7,19] Treatment recommendations have varied from closed reduction and nonoperative management to surgical treatment using external fixation, open reduction and internal fixation, excision arthroplasty of the radial head, or radial head replacement.[8,19] An increased understanding of elbow biomechanics and the constraints that aid stability, as well as improvements in fixation options, has led to significant improvements in th treatment of this uncommon injury.[13] The application of systematic algorithms and standardized surgical protocols to treat this difficult injury pattern results in improved patient outcomes.[9,15,22]

The purpose of this study was to determine the clinical and radiologic outcomes of a consecutive group of patients with terrible triad injuries of the elbow treated at a single

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Figure 1 Lateral (**A**) and anteroposterior (**B**) radiographs show a terrible triad injury.

institution. In addition, by grouping patients into those treated with open reduction and internal fixation of the radial head or those treated with radial head arthroplasty, we were able to compare the outcomes of these 2 treatment options for addressing the radial head fracture.

Materials and methods

The Orthopaedic Database (Orthoscope) at Auckland City Hospital was used to identify all patients with dislocation of the ulnohumeral joint and fracture of both the head of the radius and the coronoid process of the ulna who were seen and treated during a 7-year period. Of 30 patients who were identified and invited for clinical and radiologic review, 6 had moved overseas and were lost to follow-up, and 1 patient declined to participate. This left 24 elbows in 23 patients who were available for evaluation.

All patients completed the Disability of Arm, Shoulder and Hand (DASH)[5] and the American Shoulder and Elbow Society (ASES)[17] assessments and underwent a standardized clinical and radiologic assessment of the involved elbow. Follow-up radiographs were compared with initial radiographs and those taken immediately after the definitive surgery.

Operative technique

All elbows in this study were treated using a surgical protocol based on restoring anatomy and providing stability to allow early movement. The elbow dislocation was initially reduced closed in the emergency department under conscious sedation or in the operating room under general anaesthesia. The limb was immobilized in a posterior plaster-of-paris cast, with definitive surgery occurring within 10 days. One compound fracture dislocation was treated with definitive surgery on the day of admission.

Operations in 18 patients were by or under the direct supervision of one of the primary authors involved in the study. The technique used for all patients was to repair the injured structures from deep to superficial, with the aim being to restore bony anatomy and soft tissue stability to allow early mobilization.

A direct lateral or a universal posterior skin incision was used in all patients. The typical operative finding was an avulsion of the lateral soft tissues deep to fascia, with disruption of the lateral collateral ligament from the lateral epicondyle. All coronoids were fixed. This was performed first, using screw fixation, sutures through drill holes tied over the dorsum of the olecranon, or suture anchors, depending on the type of fracture and size of the bony fragment.

The radial head fracture was then assessed and treated. Where possible, this was repaired using screws or a small proximal radial plate and screws, or both, if the radial neck was also involved in the fracture. If fixation was not possible, the radial head was replaced using an Avante (Avanta Orthopaedics, San Diego, CA, USA), or Evolve (Wright Medical Technology, Arlington, TX, USA) radial head replacement. The decision to repair or replace and the implant choice was according to surgeon preference. In general, however, the younger the patient, the greater the effort undertaken to repair the radial head.

Finally, the lateral ligament complex was repaired back to the isometric point at the lateral epicondyle. In patients early in the study, the ligament was repaired through drill holes in the epicondyle using heavy nonabsorbable suture. The ligament repair in patients later in the study was with suture anchors placed at the isometric point. The elbow was then examined under an image intensifier to confirm reduction and to assess stability through a range of motion. Stability was assessed in the plane of flexion and extension. As long as elbows were stable out to 45° flexion, no surgery was required on the medial side.

Postoperatively, the elbow was placed in a padded posterior plaster-of-paris cast with the arm at 70° of flexion and slight pronation to protect the lateral ligament repair. This cast was removed at 7 to 10 days to allow patients to begin a supervised rehabilitation protocol focusing primarily on early active and active assisted range of motion.

Our hypothesis was that patients with radial head replacement would have a poorer outcome. Statistical analysis was performed using a Mann-Whitney U test to evaluate the difference between groups. A level of $P < .05$ was considered significant.

Results

There were 11 women and 12 men, with an average age of 43.5 years (range, 19-67 years). There were 13 right and 11 left elbows. The dominant elbow was involved in 58%. The most frequent mechanism of injury was a fall from a height onto the outstretched arm. Follow-up was a mean duration of 40.6 months (range, 16-73 months).

Orthogonal radiographs at presentation were reviewed to assess the injury pattern. Coronoid fractures were categorized according to the Regan and Morrey classification,[19] comprising 14 type 1, 8 type 2, and 2 type 3 coronoid fractures. Radial head fractures were classified according to the Mason classification,[10] consisting of 3 type 1, 9 type 2, and 12 type 3 radial head fractures.

A direct lateral skin incision was used in 18 patients and a universal posterior skin incision was used in 6. A lateral approach to the elbow joint was then undertaken in all patients, usually through the injured lateral structures, and the interval between the anconeus and extensor carpi ulnaris was used. The radial head was repaired in 15 patients and