# Terrible Triad Injuries of the Elbow

Neal C. Chen, MD,* David Ring, MD, PhD*

The treatment of terrible triad injuries of the elbow continues to evolve. Radial head fixation and arthroplasty, coronoid process fixation, and repair of the lateral collateral ligament continue to be the mainstays of treatment. In the elbow with persistent instability after repair of these elements, application of a static external fixation, hinged external fixation, ulnohumeral joint pinning, or an internal hinge may be needed. In patients who undergo treatment after the acute injury period, the coronoid may require reconstruction using radial head autograft, iliac crest autograft, olecranon autograft, or allograft. *(J Hand Surg Am. 2015;40(11):2297–2303.*

**Key words** Terrible, triad, elbow, fracture, instability.

THE TERRIBLE TRIAD OF THE ELBOW is posterior or posterolateral dislocation of the ulnohumeral joint with fractures of the radial head and coronoid process. The origins of the medial collateral ligament (MCL) and lateral collateral ligament (LCL) complexes avulse from the epicondyles and the anterior capsule fails with a transverse fracture of the coronoid tip.

The treatment of terrible triad injuries has evolved over the last decade. There is a consensus that the radial head injury and the LCL injury should be addressed, but there are differing opinions as to whether the radial head should be repaired or replaced, when the coronoid fracture should be addressed, or if the MCL requires repair. In addition, there has been an evolution in the late treatment of terrible triad injuries. This current concepts article focuses on these 2 areas of development.

*From the *Department of Orthopaedic Surgery, Hand and Upper Extremity Service, Massachusetts General Hospital, Boston, MA.*

Received for publication April 8, 2015; accepted in revised form April 25, 2015.

D.R. reports receiving grants from Skeletal Dynamics; royalties from Wright Medical; personal fees from Biomet, Acumed, universities and hospitals, and lawers; stock options from Illuminos; speaking honoraria from other universities and hospitals; and personal fees from being a deputy editor for *Journal of Hand Surgery* and *Clinical Orthopaedics and Related Research*.

**Corresponding author:** David Ring, MD, PhD, Department of Orthopaedic Surgery, Hand and Upper Extremity Service, Massachusetts General Hospital, 55 Fruit St., Yawkey 2C, Boston, MA 02114; e-mail: dring@mgh.harvard.edu.

0363-5023/15/4011-0033$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2015.04.039

## CLINICAL PICTURE

In general, terrible triad injuries are the result of a fall onto an outstretched hand. It is postulated that there is a posterolateral load upon the elbow during the fall, which results in tension failure of the LCL and the MCL, and a compressive load that fractures the radial head. Some circumstantial evidence supports this concept.

Patients generally present with pain, swelling, and limited range of motion of the elbow. Patients may or may not describe a subluxation or dislocation event. Although neurovascular injuries are uncommon after this injury, ulnar neuropathy and radial nerve palsy have been described after surgical treatment of these injuries.

## DIAGNOSIS

Radiographs of terrible triad injuries can be deceptive. In some cases, the elbow is reduced and there are small fragments of bone anterior to the ulnohumeral joint on a lateral radiograph and a radial head/neck fracture is noted on the anteroposterior view. The small triangular anterior fragment is a piece of the fractured coronoid tip and is a sign that a more substantial injury has occurred. Computed tomography scans are helpful for preoperative planning, especially for understanding the complexity of the radial head/neck fracture and the size of the coronoid fracture.

## TREATMENT AND OUTCOMES

Upon presentation, if the ulnohumeral joint is dislocated, it should be reduced. In cases in which the elbow is unstable and re-dislocates easily, surgery is

recommended to maintain a congruent elbow joint. In cases in which the elbow joint stays grossly congruent after reduction, operative intervention can maximize elbow function and prevent residual instability. Patients with a stable elbow after reduction may be considered for nonsurgical treatment, but stability and final elbow function after nonsurgical treatment may not be predictable. The residual instability results because the malunited radial head does not provide an adequate buttress to the elbow; subsequently, the soft tissues heal at a different length.

## Radial head repair versus arthroplasty

For terrible triad injuries, repair or replacement of the radial head helps prevent re-dislocation by restoring radiocapitellar contact. Radial head fracture fixation versus replacement is dictated in part by the number and character of the fracture fragments.[1] Fixation of radial head fractures with more than 3 parts (shaft and 2 articular fragments) is prone to early failure of fixation, nonunion, and limited forearm rotation when the fracture heals.[1]

If secure and stable fixation of the radial head cannot be achieved, the radial head should be replaced with a prosthesis. This determination is a matter of judgment. There is variation of opinion among surgeons in determining how many fracture fragments are present when utilizing 3-dimensional computed tomography[2] scan and even after operative visualization of the fracture.[3] Although surgeons often dread discarding intact radial head in the setting of partial articular fractures, some partial radial head fractures have small fragments and comminution at the fracture margin that can difficult to repair.[4] In addition, partial articular fractures tend to involve the anterolateral part of the radial head that is critical to elbow stability.[5] Failure of radial head fixation within days risks subluxation or dislocation of the elbow. If the fixation is adequate for 3 to 4 weeks, the repaired radial head may serve as a biological spacer that can be excised later if it becomes symptomatic.

Watters et al[6] compared 39 patients with terrible triad injuries who were treated with either open reduction internal fixation (ORIF) of the radial head or radial head arthroplasty. Three of 9 patients who underwent ORIF had instability of the elbow 18 months after surgery compared with 1 of 30 patients who had radial head arthroplasty. In a retrospective comparison, Leigh and Ball[7] found that patients with terrible triad injuries who underwent radial head arthroplasty had slightly, but significantly, higher average Disabilities of the Arm, Shoulder, and Hand scores indicating more disability than patients who underwent ORIF (10.3 vs 9.2), a difference unlikely to be clinically meaningful and possibly due to selection bias.

Fixed monopolar, fixed bipolar, and loose smooth monopolar spacer prosthetic radial head designs are available. There are some biomechanical data suggesting that bipolar arthroplasty provides less ulnohumeral stability than the other designs.[8] In the native radial head or monopolar arthroplasty, as the radius begins to displace posteriorly with respect to the capitellum, there is an increased resistance to posterior ulnohumeral subluxation; however, in bipolar arthroplasties, posterior displacement of the radius is associated with decreased resistance to ulnohumeral subluxation. Bipolar arthroplasties are associated with osteolysis around the stem.[9] Monopolar spacer arthroplasties with an unfixed stem are associated with radial neck lucency and capitellar changes,[10] although these radiographic findings do not correlate with symptoms. Fixed monopolar arthroplasties are associated with stress shielding around the radial neck of well-fixed stems, although—again—these findings are not associated with symptoms.[11]

When resources are limited, a loose monoblock prosthesis can be fashioned from methylmethacrylate cement. Sometimes, a screw is used to help make the neck of the prosthesis. Cement is inexpensive and a cement spacer helps stabilize the elbow as well as a metal spacer.

The major issue with all radial head arthroplasty designs is a prosthesis that is too long: so-called "overstuffing" of the radiocapitellar joint. A prosthesis that is too long can be painful. The abnormal length increases radiocapitellar joint pressures, erosion of the capitellum, subluxation of the ulnohumeral joint, and loss of elbow flexion.[12] Doornberg et al[13] have suggested that the lateral edge of the coronoid is a useful reference point for sizing of the radial head, and in general, the prosthesis should not lie more than 1 mm proximal to this landmark. Rowland and colleagues[14] found that a lateral portion of ulnohumeral joint space that is not parallel on anteroposterior postoperative radiographs was not a good indicator of overstuffing. A nonparallel medial joint space was a better indicator of overstuffing, but imperfect. It seems that overstuffing of the radial head may not be radiographically apparent until overlengthening is greater than 6 mm.[15]

## Coronoid fixation

*Relevant biomechanics:* Studies of the *in vitro* effect of combined injuries to the elbow on rotatory stress and the influence of repair or reconstruction of specific injury