

Elbow Trauma

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Abstract This section deals with the common trauma challenges around the adult elbow. The bony injuries to the olecranon and the distal humerus are covered, with references addressing the treatment options and consideration of the mechanics and effects of fixation. The important topic of complex dislocation, leading to the concept of the terrible triad injury and instability is dealt with in detail, as is the difficult issue of biceps tendon rupture and its treatment.

Keywords Distal biceps rupture • Distal humeral fractures • Olecranon fractures • Complex elbow dislocation

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Distal Biceps Rupture

Freeman CR, McCormick KR, Mahoney D, Baratz M, Lubahn JD. Non-operative treatment of distal biceps tendon ruptures compared with a historical control group. J Bone Joint Surg Am. 2009;91(10):2329–34.

Non-operative treatment has often been quoted as giving poor results, with significant weakness and arm cramps. The evidence for this has been lacking. This paper with large enough numbers (18 cases) and an average follow-up of 59 months has shown only a small difference. The average flexion strength measured 88 % and supination strength measured 74 % of the contralateral arm. Eight patients reported weakness on heavy lifting and six patients described weakness on activities that required supination. There were no cases of continued arm cramps. All patients had returned to work at an average of 12 weeks.

El-Hawary R, Macdermid JC, Faber KJ, Patterson SD, King GJ. Distal biceps tendon repair: comparison of surgical techniques. J Hand Surg Am. 2003;28(3):496–502.

A prospective study comparing the outcomes of nine surgical cases performed with a single incision technique using bone anchors to reattach the tendon to the bicipital tuberosity, against ten cases using the Morrey modified 2-incision technique (splitting extensor carpi ulnaris [ECU] and avoiding the ulna periosteum). The difference in outcomes between the two groups was relatively minor. The 2-incision group had a faster return to flexion strength and a significantly lower complication rate. This shows that either technique gives acceptable results with a slight preference towards the 2-incision technique.

Kelly EW, Morrey BF, O'Driscoll SW. Complications of repair of the distal biceps tendon with the modified two-incision technique. J Bone Joint Surg Am. 2000;82-A(11):1575–81.

This is a retrospective review of the modified 2-incision (Boyd-Anderson) technique. The paper gives particular

reference to the complications. Seventy-eight cases were reviewed, of which 74 were primary repairs and 4 required an intercalary tendon graft. There was a 31 % complication rate (mostly transient neural deficits). This was more common if a large anterior exposure was required. There were no cases of radioulnar synostosis (but 4 cases of heterotopic ossification) using this muscle splitting approach which was specifically designed to reduce the risk of synostosis. The complication rate was much higher if the operation occurred more than 10 days post injury.

Distal Humeral Fractures

Ljungquist KL, Beran MC, Awan H. Effects of surgical approach on functional outcomes of open reduction and internal fixation of intra-articular distal humeral fractures: a systematic review. J Shoulder Elbow Surg. 2012;21(1):126–35.

A systematic review of the literature comparing different surgical approaches. Paratricipital, Triceps split, Bryan-Morrey and Olecranon Osteotomy approaches were reviewed. All approaches required the elevation of triceps from the olecranon or the ulna. There was no significant difference in range of motion between any of the approaches but the least good arc of motion was in the olecranon osteotomy group. Patients with an olecranon osteotomy had a higher complication rate (36 %) and reoperation rate (14 %) than patients with any of the other soft tissue approaches.

Zalavras CG, Vercillo MT, Jun BJ, Otarodifard K, Itamura JM, Lee TQ. Biomechanical evaluation of parallel versus orthogonal plate fixation of intra-articular distal humerus fractures. J Shoulder Elbow Surg. 2011;20(1):12–20.

This human cadaver study assessed the biomechanics of the different plate configurations commonly used for fixation of distal humeral fractures (orthogonal and parallel). An unstable fracture model with a metaphyseal defect was

created and fixed with two plates using unlocked screws. Cyclical loading and subsequent loading to failure was performed. Parallel plate configuration was found to have significantly higher stiffness. Screw loosening occurred in all posterior plates of orthogonal construct but in none of the parallel plates. This paper suggests that parallel plating is preferential to orthogonal plating for distal humeral fractures.

Kamineni S, Morrey BF. Distal humeral fractures treated with noncustom total elbow replacement. J Bone Joint Surg Am. 2004;86-A(5):940–7.

A large retrospective study of TER inserted primarily for distal humeral fracture. The indication was for acute complex fractures that were unable to be reconstructed either because of fracture comminution or because of poor quality bone in the older patient. Forty-three elbow replacements were followed up for an average of 7 years (minimum of 2 years). The average range of motion was from 24 to 131 degrees of flexion. Ten additional procedures, including five revision arthroplasties, were required in nine elbows. Sixty-five percent of cases had an uncomplicated recovery with no complication and no further surgery. This paper shows good long term outcome when TER is used for acute fracture treatment. This is now a standard treatment for the low demand, elderly patient.

Olecranon Fractures

van derLinden SC, van Kampen A, Jaarsma RL. K-wire position in tension-band wiring technique affects stability of wires and long-term outcome in surgical treatment of olecranon fractures. J Shoulder Elbow Surg. 2012;21(3):405–11.

This paper from Holland has shown that the back-out rate and fracture gap formation is higher if the K wires are positioned in the intramedullary canal rather than in a transcortical position. The consequence of the wires becoming loose is that this group had a higher incidence of radiological

evidence of osteoarthritis. They also found that once metalwork was removed, a functional improvement was noted and thus they recommend a low threshold for advising removal of the wires and the tension band wire.

Gordon MJ, Budoff JE, Yeh ML, Luo ZP, Noble PC. Comminuted olecranon fractures: a comparison of plating methods. J Shoulder Elbow Surg. 2006;15(1):94–9.

This is a biomechanical study looking at different positions and plate configurations for a comminuted olecranon model. The study was performed on cadaver bone. The strength of dual medial-lateral plates and a single posterior plate with and without an intramedullary screw was evaluated. The strongest configuration was a posterior plate with a large intra-medullary screw passing through the plate and across the fracture. The authors concluded that this was their preferred technique.

Doornberg J, Ring D, Jupiter JB. Effective treatment of fracture-dislocations of the olecranon requires a stable trochlear notch. Clin Orthop Relat Res. 2004;(429):292–300.

Monteggia type fracture dislocations are often difficult to fix and sometimes are associated with a poor result. This paper showed that the stability of the coronoid was crucial to the outcome. Of 26 patients followed up for more than 3 years (average 6 years), 21 had a good or excellent result. The 5 poor results were as a consequence of inadequate fixation of the coronoid. These cases progressed on to arthrosis (3 cases) and proximal radio-ulna synostosis (3 cases).

Complex Elbow Dislocation

O'Driscoll SW, Morrey BF, Korinek S, An KN. Elbow subluxation and dislocation. A spectrum of instability. Clin Orthop Relat Res. 1992;(280):186–97.

This is a biomechanical cadaver study analyzing the mechanism of elbow dislocation. Thirteen cadaver elbows underwent sequential ligament release. Posterior dislocation

of the elbow was shown to occur after three sequential stages of instability, starting with the lateral ligament complex and extending medially. In 12 of the 13 elbows, dislocation was achieved with the medial collateral ligament (MCL) still intact. It was postulated from this work that a posterior elbow dislocation following a fall on the outstretched hand occurs because of an external rotation/valgus force on a flexed elbow. This paper laid the foundation for the understanding of postero-lateral instability, and the mechanics of complex elbow dislocation (Terrible Triad).

Pugh DM, Wild LM, Schemitsch EH, King GJ, McKee MD. Standard surgical protocol to treat elbow dislocations with radial head and coronoid fractures. J Bone Joint Surg Am. 2004;86-A(6):1122–30.

This paper describes the current standard treatment protocol for terrible triad injuries and its results. Radial head fractures were either fixed or replaced. The coronoid fracture was reattached most commonly with a lasso type suture. The Lateral ulnar collateral ligament was always reattached. If further instability was noted then reattachment of the MCL was performed or a hinged external fixator was applied. Thirty-six elbows were followed up retrospectively with a mean of 34 months. They achieved an average arc of movement of 112°. There were only two cases of continuing instability. Seventy-eight percent of cases had a good or excellent result as measured by the Mayo Elbow Performance score. This paper has shown that the terrible triad is a treatable condition using the standard protocol described.

Doornberg JN, Ring D. Coronoid fracture patterns. J Hand Surg Am. 2006;31(1):45–52.

This paper correlated the type of coronoid fracture with the type of elbow instability. Coronoid fracture pattern was investigated in the four most common types of elbow fracture dislocation operated on by a single surgeon. They found that large coronoid fragments (>50 %) were usually associated with both anterior and posterior olecranon fracture dislocations (Monteggia Variant type injury), Small coronoid fragments (<50 %) were identified in all cases of Terrible triad

injury. Anteromedial coronoid facet fractures were always present in Posteromedial rotatory instability.

This paper shows high statistical correlation between the type of instability and the type of coronoid fracture. It highlights that the type of coronoid fragment correlates with the type of elbow dislocation. The type of coronoid fracture will help the treating surgeon to identify the associated ligamentous injuries associated with each of the specific types of instability.

Doornberg JN, Linzel DS, Zurakowski D, Ring D. Reference points for radial head prosthesis size. *J Hand Surg Am.* 2006;31(1):53–7.

If the radial head is fractured and unreconstructable, the radial head will need to be replaced. The main complication from radial head replacement is inserting an implant too long (“overstuffing”). This paper assessed the normal position of the radial head in relation to the lateral edge and central ridge of the coronoid process. Using 3-dimensional computed tomography (CT), they showed that despite significant variability, the radial head articular surface lies approximately 1 mm proximal to the lateral edge of the coronoid articular surface. This defines the reference point for correct positioning of the radial head implant, in order to avoid overstuffing.

Sorensen AK, Søjberg JO. Treatment of persistent instability after posterior fracture-dislocation of the elbow: restoring stability and mobility by internal fixation and hinged external fixation. *J Shoulder Elbow Surg.* 2011;20(8):1300–9.

The main risk following an elbow dislocation is continuing instability with a further subluxation or dislocation. Such a situation has an increased risk of further re-dislocation and instability. The addition of a hinged external fixator to protect the repaired ligaments has been shown by this paper to prevent further instability but was associated with a 41 % complication rate. The end results were better in patients who underwent treatment within 6 weeks of injury compared to those having treatment later than 6 weeks post injury.