The Surgical Management of Complex Intraarticular Fractures of the Distal Humerus

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Intraarticular fractures of the distal humerus are difficult to treat. This article reviews the contemporary literature on surgical management of these fractures.

The overall incidence of distal humeral fractures is 5.7 per 100,000 of the population per year, with a bimodal distribution. The mean age of patients sustaining distal humeral fractures is 48.4 years, with the peaks of greatest incidence primarily representing a young male population who injure themselves through sport and road-traffic accidents and an elderly female population injured through simple falls. A recent review of the Finnish National Hospital Discharge Register has shown a substantial increase in the second peak of the bimodal distribution. With life expectancy continuing to increase it is anticipated that a greater number of these fractures will require treatment in the future.

Improvements in osteosynthesis techniques and instrumentation have changed the treatment of these injuries. Prior to the 1970s, bicondylar intraarticular fractures were traditionally treated conservatively with skeletal traction, collar and cuff, or closed manipulation and cast application. During the 1970s and 1980s surgical fixation became the treatment of choice. A review of 42 patients with intra-articular bicondylar fractures of the distal humerus by Zagroski et al clearly highlighted the benefits of anatomical reconstruction and rigid internal fixation. Patients were evaluated as to their functional results using the criteria defined by Bickel and Perry. Results were classified as excellent, good, fair, or poor. Of the patients treated by open reduction and internal fixation, 76% had an excellent or good result, increasing to 88% if the reduction was anatomical. Of the patients not treated with primary ORIF, only eight percent had an excellent or good result.

Early fixation methods relied on screws alone before plate constructs were introduced. In vitro biomechanical research however have proved the superiority of a double plate configuration, regardless of the type of plate used. The more recent literature has questioned the importance of the traditional 90/90° plates configuration, which was based on the stiffness of the construct when 1/3 tubular plates were used. In-vitro and cadaveric studies have now confirmed the adequacy of both compression and torque stiffness with parallel plating, specifically if locking screws are employed. The 1/3 tubular plates which once were in favour due to malleability and ease of contouring have now been superseded by anatomically contoured plates, largely alleviating the need for intra-operative plate bending. The option of lock screws has improved the bone-implant anchorage particularly in elderly patients with osteopaenic bone.

The failure of fixation typically begins in the lateral column, with repetitive varus stresses across the elbow resulting from the force of gravity acting through the forearm lever arm. The resulting varus torque across the elbow distracts the lateral column away from any fixation placed along its posterior surface. To counteract this a lateral plate applied parallel to the medial side has been proposed. The theoretical advantage of such a plating configuration is it allows interdigitation of screws in the osteopaenic articular fragments, combined with the stiffness of the plates. The interdigitation and locking of the screws together as they pass through the distal fragments creates the architectural equivalent of an arch.

The majority of fixation failures after a distal humeral fracture occur at the supracondylar level. If fixed with traditional methods, the metaphysis-diaphysis...
junction will be dependent on only 2 or 3 screws for stability. The fixation strategy however should concentrate on maximising fixation strength in this area. The plates should be applied such that compression is achieved at the supracondylar level for both columns. Precontoured parallel plates have the advantages of both maximising construct stiffness specifically at the supra-condylar level and if the fragments do not align with the contour of the plates it is most likely that it is the bone reduction that is imperfect and not the plate position. Another problem with placing the plate posterolaterally is that screw fixation in the lateral column distally is often limited to 1 or 2 small short screws passing through the plate from posterior to anterior. As the capitellum pulls away from the plate, the entire distal humeral segment becomes unstable.

For the intra-articular shear type fractures, headless compression screws are usually sufficient (Fig 3). The biology of the fracture is also important and the surgeon should appreciate the insufficiency of the osseous micro-architecture in the posterior aspect of the distal humerus. The thinning of the posterior cortex and the reduced posterior trabecular bone volume potentially has implications for positioning plates posterolaterally. Another factor to consider when positioning plates is the blood supply. Several cadaveric studies investigating the arterial anatomy of the human adult elbow have identified the importance of segmental posterolateral vessels. The posterior dominance of the blood supply to the distal lateral humerus suggests that when fractures are fixed with posterolateral plates surgery should be performed with minimal periosteal elevation or alternatively plates should be avoided in this region to avoid damage to these perforating vessels.

The outcomes following open reduction and internal fixation (ORIF) have been documented using subjective, objective, radiographs and complication measures. Various subjective patient rated scores have been used to assess outcomes in these injuries including; the Disabilities of the Arm Shoulder and Hand (DASH), Ulnar Nerve Evaluation [PRUNE], American Shoulder and Elbow Surgeons Elbow form [ASES-e], and the Short Form-36 [SF-36]. Studies have also used objective outcomes alone, as well as a combination of subjective and objective measures such as the Mayo Elbow Performance Score (MEPS), Broberg and Morrey functional rating index, the Orthopaedic Trauma Association assessment, the Jupiter outcome and the Bickel and Perry outcome. Overall using the range of scores available, 56-87% of patients have a good or excellent outcome following ORIF. Patient satisfaction has been reported as high as 85-95%, with 75% of patients returning to their pre-injury level of occupation and activity. Mean post-operative pronation-supination arcs have been measured between 97-112° with average pronation-supination arcs from 151-165°. Age over 50, poor bone quality and open fractures are associated with an inferior outcome. Complications of open reduction and internal fixation include; non-union, mal-union, ulnar neuropathy, heterotopic ossification, post-traumatic arthritis and infection. Non-union or metal work failure requiring further surgery has been recognised in 0-13% of patients, 75% of these are due to an inadequate initial surgical fixation. Deep infection rate is 0-8%. Ulnar neuropathy happens in 0-15% of patients post operatively. Heterotopic ossification has been reported in 13% of patients, with a trend to develop heterotopic bone in patients not receiving indomethacin prophylaxis. There is currently however no level 1 evidence to support or dismiss the use of indomethacin.

The current consensus from the literature is that in young patients, anatomical reduction of the joint surface and stable internal fixation is the gold standard. There has however been much debate as to whether internal fixation or primary total elbow arthroplasty is the most appropriate treatment in the elderly with osteoporotic bone. A recent Canadian prospective, randomised, multicentre controlled trial has compared ORIF with primary semiconstrained total elbow arthroplasty (TEA) in complex...
bicondylar intra-articular fractures in the elderly. Twenty-one patients were randomised to each treatment group and followed for two years. The primary outcome measure was the reoperation rate, and the secondary outcome measures were patient outcome, evaluated using the MEPS and DASH scores. Reoperation rates for TEA (12%) and ORIF (27%) were not statistically different. There were however 5 fractures (25%) initially randomised to ORIF that underwent intraoperative conversion to TEA because of severe comminution and an inability to obtain stable fixation. Patients who underwent TEA had significantly better MEPSs at 3 months, 6 months, 12 months, and 2 years, as well as significantly better DASH scores at 6 weeks and 6 months but not at 12 months or 2 years. Although there was a trend toward improved motion in the TEA group the mean extension, flexion, and arc of motion of flexion-extension were not significantly different between the two groups at 2 years. There was a significantly decreased operative time in the TEA group.

The same experience was noted in a retrospective review. 24 Twenty women older than age 65 who sustained distal humerus fractures treated with ORIF or TEA were followed up for a minimum of 2 years. Using the MEPS, the outcomes of the 12 patients treated with ORIF were 4 excellent, 4 good, 1 fair, and 3 poor. Outcomes of the 12 patients treated with TEA were 11 excellent and 1 good. No patients treated with TEA required revision during the period of the study. The low numbers in each group might be responsible for the lack of statistically significant difference observed. It should also be noted that eight out of twelve patients in the TEA group had rheumatoid arthritis.

Garcia et al reviewed a consecutive series of 19 patients with fractures of the distal humerus treated by Coonrad-Morrey TEA (Zimmer). 25 The indications for surgery were fracture comminution and osteopaenia in patients over the age of 60 years. Two patients died and one patient developed dementia before any prolonged period of follow-up. The remaining 16 patients were assessed clinically and radiologically at a mean follow-up of three years (1 to 5.5). At follow-up, 11 patients (68%) reported no pain, four (25%) had mild pain with activity and one patient had mild pain at rest. The mean flexion arc was 24° to 125°. The mean supination-pronation arc was 160°. No elbow was unstable. The mean DASH score was 23 (0.92 to 63.3). The mean MEPS was 93 (60 to 100). 94% was satisfied with the outcome. Radiographs showed that 15 implants were well fixed with no evidence of loosening at final follow-up.

Kamineni et al retrospectively reviewed a series of 49 acute distal humeral fractures in 48 patients treated with TEA as the primary option. 26 Forty-three patients were followed for at least two years (6 fractures in 5 patients were excluded due to a less than a two-year follow-up), with an average duration of follow-up of seven years. The average age of the patients was sixty-nine years. The average post operative flexion arc was 24° to 131° and the MEPS averaged 93.

The concept of humeral hemiarthroplasty has recently been introduced as an alternative option to TEA, with a short series of 4 patients treated with Kudo humeral hemiarthroplasty reported. All four patients had a good or excellent outcome at short-term follow-up. 27 These studies confirm the conclusion that primary TEA is an acceptable option for the management of comminuted bicondylar fractures of the distal humerus in the elderly, in younger patients however every effort should be made to primarily fix the fractures as the expected life expectancy outweighs the implant longevity. If the fracture is very complex and fixation is considered to be beyond the surgeon’s technical experience/expertise, then onward referral to a specialist elbow unit is mandatory.

Although there is evidence for carrying out a primary TEA for these complex injuries in an elderly population, many surgeons prefer to carry out a primary ORIF to avoid the long-term complications associated with TEA. Unlike TEA a successful ORIF should allow the elbow to continue to function well in the long term without requiring further reconstructive surgery. 28 In cases where ORIF fails due to non-union, TEA still remains a surgical option. Whether the outcome is better after an acutely performed TEA or a TEA following a non-union is a matter of debate. Sivardeen et al retrospectively compared the results of primary TEA and TEA after failed ORIF, with a mean follow up of five years. 29 There were nine TEAs following failed ORIF group and 12 had a primary TEA. The patients receiving a primary TEA had a significantly higher MEPS than those having a TEA after a failed ORIF. Prasad et al however did not find a significant difference in outcome or the rate of complications when they retrospectively reviewed a series of patients undergoing delayed and early TEA. 30 A total of 32 patients with 15 in the early treatment group and 17 in the delayed treatment group were studied. Of these patients, 15 had been referred with acute fractures of the distal humerus and received a primary TEA on average two weeks after their injury. The mean age of these patients was 78 years (61 to 89). There were 17 patients who were referred with painful nonunion of a fracture of the distal humerus that received a delayed TEA 56 weeks (16-96) after their initial injury. Of the 17 patients, 13 had undergone unsuccessful attempts at fixation. The remaining four had been treated conservatively in plaster. The mean age of this delayed group was 73 years (61 to 86). The percentage of excellent to good results based on the MEPS was not significantly different, 84% in the early group and 79% in the delayed group. Subjective satisfaction was 92% in both the groups. The Kaplan-Meier survivorship analysis for the early and delayed treatment groups was 93% at 88 months and 76% at 84 months, respectively. No significant difference was found between the two groups.

In summary, intra-articular distal humerus fractures are complex injuries requiring an experienced surgical approach. The literature has identified consistently good outcomes following open reduction and internal fixation. Provided internal fixation is done well it is the most suitable option for these injuries. Total elbow arthroplasty has a role, particularly in an elderly population where the potential of long-term complications is lower. Hemiarthroplasty may also be an option in the elderly, but long term results are not available. There is a need for further prospective studies.
References


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