Rate of Union in Complex Distal Humerus Fractures Using Anatomically Contoured Locking Plates

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ABSTRACT

Objective: A study to evaluate the rate of healing after open reduction internal fixation of complex distal humerus fractures using LCPs.

Design: Observational study.

Setting: Liaquat National Hospital, an orthopaedic trauma unit, which provides all the fracture care for a well-defined catchment population.

Method and Material

Patients/Participants: A consecutive series of 25 patients with distal humeral fractures admitted to the unit between July 2010 and April 2013.

Intervention: We adopted a protocol of open reduction and fixation of all displaced intraarticular fractures (greater than 2 mm of displacement in any plane) in patients who were medically fit for anesthesia. Each case underwent osteosynthesis with distal humerus posterolateral and medial anatomically contoured locking plates via transolecranon approach using chevron osteotomy. 4mm partially threaded cancellous screw was used for augmenting intra-articular fragments in most cases. Postoperative immobilization was a back splint for 2 weeks. Elbow range of motion was started at 3 weeks. Radiological union, postoperative elbow range of motion and complications were recorded at 4 weeks, 8 weeks, 12 weeks and then at 6 months. Patients with open fractures, undisplaced fractures or who were medically unfit were excluded from this study.

Results: Out of 25 patients included in this study, 11 (44%) were female and 14 (56%) were males, with male to female ratio of 1.27:1 .Our patients' age ranged from minimum 18 years to maximum 50 years with the mean age of 37 years. The mechanisms of injury included falls from height in 4 patients and motorcycle or motor vehicle collisions in 21 patients. Right hand dominancy was noted in 17 patients out of 25 with gender difference of male to female ratio was 2.28:1 for right hand dominance and 1:1 in left hand dominance. Using AO classification, 5 fractures were classified as Type C1, 15 were Type C2 and 5 were Type C3. Operative time was average 75 minutes (ranged from 60 to 90 minutes). Union was achieved normally in 18 patients at 12 weeks and remaining 2 patients achieved delayed union at 18 weeks and 20 weeks. All the fractures were stable on healing. Complication of ulnar nerve neuroprexia was noted in 1 out of 25 patients, which got resolved in 5 months period. One patient required removal of intercondylar screw because of soft tissue impingement. On evaluating, mean arc of motion ranged from 10^{o} to 120^{o}. All patients achieved union with good range of motion and functional activity.

Conclusions: Complex Intra or extra articular distal humerus fractures are a challenge to manage and require anatomical stable fixation. Anatomically contoured angular stable implants facilitate operative reduction and stabilization of the fracture and may allow early postoperative rehabilitation. Clinical and radiological results show good healing rate with reasonable range of motion.

Key Words: complex distal humerus fracture, Anatomically contoured locking plates, open reduction and internal fixation, Intra-articular.

INTRODUCTION

Fractures of the distal humerus are rare as they account only for approximately 2% of all fractures[1,2]. Distal humerus fractures with intra-articular extension are complex injuries that require meticulous approach for fixation. The principle involves anatomical reduction and absolute fixation with perfect stabilization of extraosseous implants. The functional outcome has been greatly influenced by the early graduated rehabilitative exercise[2].

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Gold standard care is anatomical and stable open reduction and internal fixation[3,4,5,6,7]. This demands for a skillful work by an expert surgeon. Good Preoperative planning, templating and meticulous intraoperative fixation are the key to success taking good care of soft tissues including ligamentous stabilizers of the elbow. In spite all these measures are taken, if the post-operative rehabilitation is improper, the surgery is never going to produce a good range of motion and acceptable functional outcome.

Complex intra-articular fractures have been reported to have variable functional outcome, for several reasons, for example, complex anatomy of the distal humerus and its articular surface, contracture of the capsule, soft tissues around the elbow, resulting from trauma or surgery. The complications associated with both, the injury itself or the operative intervention includes elbow contracture with loss of motion, ulnar nerve neuropathy, malunion, and nonunion and heterotopic bone formation.[11,12.]

The goal of treatment for distal humerus fractures is a painless stable elbow with satisfactory range of motion. Anatomically preshaped posteolateral and medial locking compression plates allow angular stable fixation of these complex fractures. These plates provide better biomechanical stability and enhanced anchorage in these complex injuries. Due to better fixation and strong plate to bone interface, early functional rehabilitation is possible.

Therefore, the aim of the study was to evaluate early clinical and radiographic fracture healing, functional range of motion and assessment of complications using Locking compression Plating.

MATERIALS AND METHODS

This is a retrospective review of 25 patients treated for complex elbow intra-articular and periarticular fractures involving the distal humerus over a period from July 2010 – April 2013. All patients completed the required follow up. Exclusion criteria of study were patients operated with percutaneous K Wires, conventional plating, treated not primarily at LNH Karachi and those who were managed conservatively.

All of our patients underwent Open Reduction and Internal Fixation within 5 days of the injury. Patients were placed in the lateral decubitus position and a standard posterior exposure was performed using transolecranon chevron shaped osteotomy (described below) via posterior midline approach. After identifying and preserving ulnar nerve, plate fixation was performed in all cases with medial and lateral column fixation using medial and posterolateral compression plates. K wires were used to provisionally control reduction of fracture fragments. 4mm partially threaded cancellous screw was used for augmenting intra-articular fragments in most cases, except where comminution was observed. Interfragmentary lag screws were used if necessary to hold metaphyseal and diaphyseal fragments. Olecranon osteotomy was closed via either a 6.5mm cancellous screw with washer alone, or with/without tension band wiring. All wounds were closed with reduvic drain placement. Long arm plaster splint was applied in all cases.

The distal humeral articular reductions and post-fixation olecranon osteotomy articular reductions were independently assessed for accuracy via immediate postoperative AP and lateral radiographs. An articular reduction of <2mm step/gap was considered satisfactory, whereas reductions with greater displacement were considered unsatisfactory. Radiographic magnification was accounted for during this assessment.

Patient records were reviewed to determine intraoperative and postoperative complications, duration of surgery, union rates, and subsequent procedures performed. Osteotomy union was defined as replacement of the radiolucent osteotomy site with bone on anteroposterior (AP) and lateral radiographs, and the initiation of resistive elbow extension exercises. Operative time was defined as the time period between initiation of the skin incision to the conclusion of the application of sterile bandages and upper extremity splint.

Follow-up

The first postoperative follow-up was at 2 weeks after discharge for wound examination and removal of sutures. Passive range of motion was started at 2 weeks under the supervision of a physiotherapist. Subsequently follow-up with 4 weeks intervals until fracture was united i.e. at 4 weeks, 8 weeks, 12 weeks and then at 6 months. At each follow-up visit, anteroposterior and lateral radiographs of the elbow were obtained and clinical results assessed and noted. A retrospective review of patient charts and radiographs was performed. In addition, patients were clinically evaluated for range of motion,

including arc of flexion–extension and pronation–supination, measuring with a handheld goniometer. Stability of the elbow was evaluated on the basis of history and physical examination. Data pertaining to complications such as loss of motion arc, ulnar nerve neuropraxia and heterotropic ossification were also recorded.

Fractures considered to be united normally if union was observed clinically as well as radiologically till 12 weeks of fixation. A delayed union was diagnosed if the fracture healed between 12 and 24 weeks; nonunion was considered to be present if the fracture was not clinically or radiologically united after 24 weeks post injury or sooner if implant failure was associated with displacement of the fracture.

RESULTS

Out of 25 patients included in this study, 11 (44%) were female and 14 (56%) were males, with male to female ratio of 1.27:1 .Our patients' age ranged from minimum 18 years to maximum 50 years with the mean age of 37 years. The mechanisms of injury included falls from height in 4 patients and motorcycle or motor vehicle collisions in 21 patients. Right hand dominancy was noted in 17 patients out of 25, with gender difference of male to female ratio was 2.28:1 for right hand dominance and 1:1 in left hand dominance. Using AO classification, 5 fractures were classified as Type C1, 15 were Type C2 and 5 were Type C3. Operative time was average 75 minutes (ranged from 60 to 90 minutes). Union was achieved normally in 18 patients at 12 weeks and remaining 2 patients achieved delayed union at 18 weeks and 20 weeks. All the fractures were stable on healing. Complication of ulnar nerve neuroprexia was noted in 1 out of 25 patients, which got resolved in 5 months period. One patient required removal of intercondylar screw because of soft tissue impingement. On evaluating, mean arc of motion ranged from 10^{o} to 120^{o}. All patients achieved union with good range of motion and functional activity.

DISCUSSION

The treatment of complex intra-articular distal humerus fractures is technically demanding with predictive high incidence of complications. Distal humerus has a complex articular anatomy, which should be clearly understood, and fractures should be interpreted in the light of proper Anteroposterior and lateral radiopgraphs as well as Computed Tomogram. In young patients included in our study, most of these injuries occur from high-energy trauma.

Radiological classification was carried out using the AO system by Muller et al. [13] which is identical to the Orthopaedic Trauma Association (OTA) classification for fractures of the distal humerus. It was evident that there was a tendency to underestimate the severity of comminution and intra-articular involvement using radiologic criteria alone; therefore, operative findings in those patients treated surgically were considered to provide definitive classification. In this series of 20 complex intercondylar fractures of the distal humerus, 5 fractures were classified as Type C1, 15 were Type C2 and 5 were Type C3 fractures. Only closed fractures were studied in this series.

Trans-olecranon approach, as described by Cassebaum.[14,15]was used as a means of direct visualization of distal humeral articular surface. Although, previous clinical reports have identified delayed and/or nonunion in approximately 10% of patients and prominent hardware in approximately 25%.[16,17], we have seen no complications pertaining to healing of the osteotomy site in our series using either 6.5mm intramedullary cancellous screw (with washer) alone or with tension band wiring.

All patients had regular follow ups in our outpatient department. We followed 5 type C1, 15 type C2 and 5 type C3 fractures. Normal Union clinically as well as with radiological healing was observed in all 5 C1 fractures (100% union) at 12 weeks. Out of 12 type C2 fractures, 11 (91.66%) achieved normal union at 12 weeks but 1 fracture (8.33%) showed delayed union at 18 weeks. Out of 3 type C fractures, 2 (66.6%) healed normally and 1 fracture (33.3%) healed with delayed union at 20 weeks. We observed zero percent non-union rate in our study, mainly because the young active and healthy persons with average age 37 years were taken in this study sample including the fact that all injuries were closed and dealt with meticulous aseptic measures in operation theatre.

Mean arc of motion at union was 110^{o} with a mean flexion contracture of 10^{o} (range, 5^{o} to 15^{o}) and mean flexion of 120^{o} (range, 80 to 140^{o}). Forearm pronation averaged 80^{o} (range, 60^{o} to 90^{o}), whereas forearm supination averaged 75^{o} (range, 50 to 90^{o}). We consider that institution of early active range of motion of exercises at 3 weeks of fixation and passive gentle physiotherapy started 2 weeks later thereafter in the supervision

of senior physiotherapist bring forth to good range of motion arc in our patients.

Ulnar nerve was identified and preserved in all cases preoperatively. Still 1 out of 25 patients (4%) encounter ulnar nerve neuropraxia, which recovered in next 4 months time. No tourniquet palsy was noticed in any case, co-relating with short tourniquet time, on average 75 minutes. One patient (4%) required removal of intercondylar screw because of soft tissue impingement. The screw was removed after union with acceptable range of motion was achieved.

We observed no complication pertaining to nonunion of olecranon osteotomy site, heterotopic calcification or painful hardware of olecranon osteotomy closure requiring removal.

Study Limitation:

The main weaknesses in our study were relatively small sample size and its retrospective study design. However because all patients were young, had closed fractures, managed with ORIF with locking orthogonal plates by a single orthopaedic surgeon, there are no selection biases in the treatment protocol.

CONCLUSION

Our study reveals good healing rate dealing complex distal humerus fractures utililizing locking pre-contoured anatomical plates in orthogonal fashion in relatively young population. These fractures require anatomical reduction after proper exposure to articular surfaces via trans-olecranon osteotomy and stable fixation using intercondylar screw and locking plates. These pre-contoured plates not only show a good purchase via locking mechanism in relatively thin cancellous bone of distal humerus but also preserving periosteal blood supply helps in timely healing. Institution of early active and passive range of motion exercises is the key stone in bringing good motion arc of elbow as well as union especially at olecranon osteotomy site in case tension band wiring is used. In a nut shell, distal humerus fractures can be managed conveniently through pre-contoured locking plates with good healing and functional activity.

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