Original Article

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Management and Functional Outcome of Closed Intercondylar Distal Humerus Fractures Treated with Dual Plating in Adults.

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Abstract

Background: This study is to report our experience in the management of closed intercondylar distal humerus fractures in adults with dual plating and to validate the therapeutic choices of our treatment.

Materials And Methods: 30 closed intercondylar distal humerus fractures with mean age of 39.6 years were included. Fractures were graded according to Riseborough and Radin classification. All patients were operated through Transolecranon approach, 17 patients underwent Parallel plating and 90-90 plating technique was done in 13.

Results: 30 elbows were reviewed at a mean follow up of 18.5 months. The average time of union was 3.25 months. Mean arc of extension - flexion was 111 ° with 90-90 plating and 99° with parallel plating technique. Mean arc of pronation – supination was 117° with 90-90 plating and 113.5° with parallel plating technique. The mean Mayo Elbow Performance Score was 76. There was a statistically significant association between mean time of union and type of fracture (p = 0.004), dominant side and functional outcome also had a statistically significant association (p =0.03).

Discussion And Conclusion: Principle of surgical management is based on restoration of joint anatomy and stable fragment fixation. The biomechanical behavior of the osteosynthesis depends more on plate configuration than plate type. We conclude that dual plate technique provides good fixation for closed intercondylar distal humerus fractures if proper preoperative planning, good reduction and surgical technique are followed, leading to high rate of bone union and minimal soft tissue damage.

Keywords: Adult, Closed intercondylar humerus fractures, Fracture Fixation, Postoperative complications, range of motion, Treatment Outcome

Introduction

Intercondylar fractures of the distal humerus in adults are rare and notoriously difficult to treat.(1) Elbow fractures encompass a spectrum of severity from low energy nondisplaced fractures to high energy fractures with associated severe soft-tissue injury.(2)

Non-operative management of these fractures may lead to either pseudoarthrosis with gross instability or a painful stiff elbow.(3, 4) Many surgeons believe that intercondylar distal humerus fractures need to be treated operatively to achieve optimal patient outcomes. Although good internal fixation results have already been reported with these fractures, over the past 30 years; the number of revisions for loss of reduction, non-union and implant failure has been high.

Various methods of surgical fixation have been described, with bicolumnar plating being the most popular. Controversy over fixation techniques and the introduction of recently developed implants, including precontoured plates and locking plates, have led to renewed focus on biomechanical testing of various fixation constructs.(5) Compared with parallel fixation, 90-90 plate fixation had significantly greater torque to failure load. Both plating constructs are equally sensitive to bone density. Both techniques had the same mode of failure in torsion.(6) The technique of dual plate for the treatment intercondylar fractures of the humerus offers many advantages, such as sufficient exposure, stable fixation and earlier exercise. The quality of elbow function following intercondylar fractures is related to the degree to which normal anatomic relationships are restored. Biomechanical and clinical studies have shown that the double-plate technique, where the plates are placed at right angles to each other (orthogonal, medial, and posterolateral), cannot sometimes provide adequate stability for some types of fractures. To overcome this problem, a parallel plating technique has already been developed by moulding the plates to the anatomical curve of the distal humerus. The stability achieved by this fixation construct combines the features and stability of an arch, while locking the two columns of the distal part of the humerus together.(7)

Functional exercise in the early period is the crucial factor of enhancing the therapeutic effect.(8) On the basis of the results reported in the more recent series, fixation with two plates at 90 degrees angle with one another or parallel to each other has become the standard against which all other treatments are measured. Despite the confidence in operative fixation that believes this shift in treatment preference, these remain challenging fractures to treat

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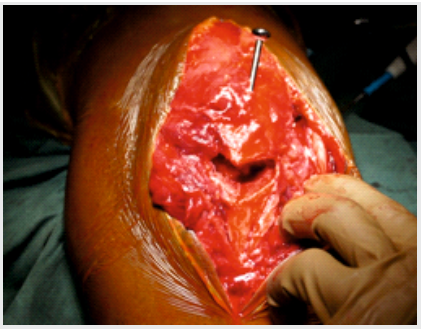

Figure 1: Chevron Olecranon Osteotomy

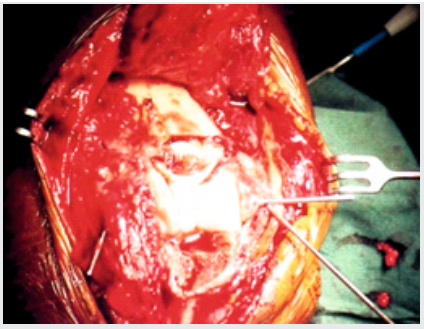

Figure 2: Reduction of fracture fragments with K- Wires.

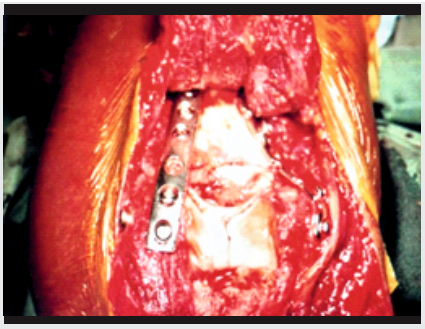

Figure 3: 90/90 Perpendicular Plating technique.

effectively and best managed by surgeons with interest and experience in skeletal trauma involving upper extremity.

Although dual plating is the preferred modality of surgical intervention in intercondylar distal humerus fractures, it has its own demerits in the form of pain, stiffness, nerve injury, infection, implant loosening, heterotopic ossification and delayed union.

This study will help us in defining the role of dual plates in the treatment of distal end humerus intercondylar fractures. The study is justified for the fact that it will be one of the solutions for the age old complications associated with the treatment of intercondylar humerus fractures with traditional plates as well as postoperative loss of reduction due to their inherent lack of rigidity and in some cases it eventually results in implant failure.

Materials And Methods

A prospective study of 30 patients with stable or unstable and communited closed intercondylar distal humerus fractures with or without osteoporotic changes treated over a period of 3 years between February 2013 to January 2016 including the follow up period were enrolled and their clinical results were assessed. Children with intercondylar distal humerus fractures in whom, growth plate was still open, patients lost in follow – up and patients managed conservatively for other medical reasons were excluded from the study.

Our series included 20 males and ten females of mean age of 39.6 years (range, 18-65 years) at the time of trauma. Right side was affected in 19 cases and left side in 11 cases and 19 patients had fracture of the dominant side.

The most common mode of injury was road traffic accidents in 16 cases followed by fall in 14 cases. The initial assessment included anteroposterior (A/P), lateral and oblique radiographs of the elbow followed by CT scan. Fractures were graded according to Riseborough and Radin classification (9): Type I: Non-displaced fracture between the capitulum and trochlea; Type II: 'T' shaped fracture with separation of capitulum and trochlea without appreciable rotation of the fragments in frontal plane; Type III: 'T' shaped fracture with separation of fragments with rotational deformity; Type IV: Severe comminuted articular surface with wide separation of humeral condyles. Our series included two Type I fracture, five Type II fracture, seven Type III fractures and 16 Type IV fractures.

Operative Technique

General anaesthesia was used in 22 cases and brachial plexus block in 8 cases. All patients were operated in lateral decubitus position with forearm hanging by the side over a sand bag. All patients were operated through Transolecranon approach and all reduced condyles were provisionally fixed with Kirschner wires. In all patients medial and lateral pillars were reconstructed using 3.5mm plates, either reconstruction plates or dynamic compression plates or locking compression plates or locking reconstruction plates and screws. The coronal fractures were fixed with orthogonal or 90-90 plating and the low intercondylar fractures were fixed with parallel plating. In our study, 17 patients were treated

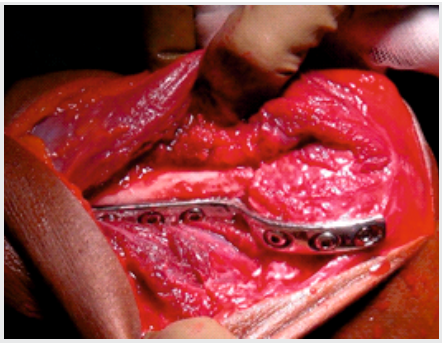

Figure 4: Parallel Plating technique

Figure 5: AP view

Figure 6: Lateral view

Figure 7: Oblique view

Figure 8: AP view

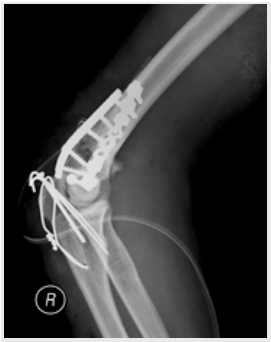

Figure 9: Lateral view

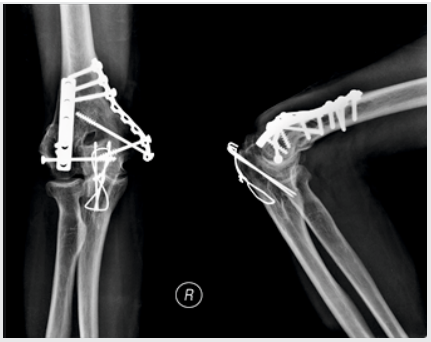

Figure 10: AP and Lateral Views After 6 Months post operative

Figure 11: AP view

with Parallel plating technique and 13 patients were treated with 90-90 plating technique. Primary autogenous bone grafting from iliac crest was done in four cases with severe comminution of fracture fragments. Intraoperatively the stability of the internal fixation was tested by putting the elbow through the range of motion. Tension band wiring was performed to fix olecranon osteotomy supplemented with k-wires or a 6.5mm cancellous lag screws. A suction drain and posterior slab was used in all the patients.

Post Operative Management

Check X-ray of elbow both anteroposterior and lateral views were obtained. Patients were instructed to keep the limb elevated and move their fingers, wrist and shoulder joints. Suction drain was removed after 48 hours. Wound inspection and dressing was done daily. Injectable followed by oral antibiotics and analgesics were given to the patient till the time of suture removal. Patients were advised to remove the suture on the 14th post operative day at our hospital.

Post Operative Physiotherapy

Continuous passive motion was started on third post operative day immediately after drain removal as per patients tolerance followed by active mobilization as soon as wound healed and swelling subsided. Patients were discharged with the forearm in an arm pouch and advised to perform shoulder, elbow, wrist and finger movements. Patients were advised not to lift heavy weight or exert the affected upper limb. On further follow up patients were instructed to carry out physiotherapy in the form of active flexion-extension and pronation-supination without loading as per patient's tolerance.

Method of Evaluation

30 patients (30 elbows) were reviewed at a mean follow up of 18.5 months (range, 12 to 30 months) and were clinically and radiologically evaluated. No patients were lost to follow up. Patients were clinically assessed according to the Mayo Elbow Performance Score, on the basis of pain, mobility, stability and functional evaluation. Radiographic assessment of the elbow, based on A/P and lateral views was performed at last follow up.

Statistical analysis:

Statistical analysis was done by using Microsoft Excel and SPSS-22. Proportions and percentages were obtained for qualitative type of data and mean, standard deviation and standard error were obtained for quantitative type of data. ANOVA (Analysis of Variance) was applied to check the significant difference between time for union and different fracture types. Unpaired "t" test was used to compare the difference in mean time for union and plating method. Fisher's exact test was used to check the association between Outcome and type of fracture, dominant side and plating method.

Results

The mean Mayo Elbow Performance Score, evaluated in 30 patients (30 elbows) was 76 (range, 55 to 100).The functional outcome based upon Mayo Elbow Performance Score at the end of 6 months was excellent in four patients, good in 20 patients, fair in four patients, poor in two patients. There was a statistically significant association between mean time of union and type of fracture ($p = 0.004$), dominant side and functional outcome also had a statistically significant association ($p = 0.03$).

Clinical Outcomes

Twenty four patients had no pain while four reported to have mild pain on lifting heavy weights. Two patients

Figure 12: Lateral view

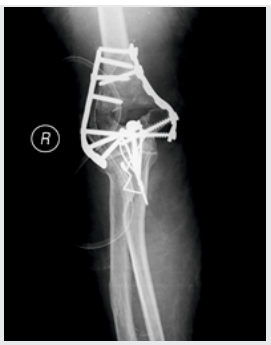

Figure 13: AP view

Figure 14: Lateral view

suffered from severe pain. The average time of union was 3.25 months (range, 2.5 to 4 months). Maximum number of fractures united at 3 months. All fractures and olecranon osteotomies united and none of the patients had non-union. Mean arc of extension - flexion was 111 degrees with 90-90 plating and 99 degrees with parallel plating technique (range, 50 to 130 degrees). Mean arc of pronation – supination was 117 degrees with 90-90 plating and 113.5 degrees with parallel plating technique (range, 60 to 150 degrees). Elbows were stable in flexion-extension and varus-valgus in all the cases.

Radiographic Findings

A/P and lateral radiographs were systematically performed in all reviewed patients. All elbows were well centered on radiographs. One patient had backed out screws and one patient developed heterotopic ossification confirmed by radiographs.

Complications

We encountered 5 postoperative complications. One patient with superficial infection which resolved with antibiotics after culture and sensitivity testing, one with ulnar neuropathy in the immediate post-operative period which spontaneously recovered by four weeks, one patient with pain at the tip of the olecranon, one patient had backed out screws which necessitated screw exchange and one patient with significant comminution developed heterotopic ossification which was treated conservatively, as the patient did not have pain and satisfactory range of motion. There was no arm length shortening. None of the patients had clinical or radiological evidence of secondary osteoarthritis.

Discussion

Intercondylar fractures of the distal humerus in adults are difficult management problems on account of the complex anatomy of the elbow, small sized fracture fragments and the limited amount of sub-chondral bone, which is often osteopenic.(10) Surgical management is the preferred treatment for intercondylar distal humerus fractures. The main goals of operative treatment are restoration of joint anatomy and stable fragment fixation. Only attaining these goals permits early initiation of physical therapy, which ultimately is the pre requisite for regaining a functional range of elbow motion.(11-13)

Controversy over fixation techniques and the introduction of recently developed implants, including precontoured plates and locking plates, have led to renewed focus on biomechanical testing of various fixation constructs.

Biological And Biomechanical Aspects

Optimal treatment of elbow fractures aims for expeditious fracture healing with early recovery of strength on one hand and for the immediate recovery of pain free mobility on the other hand. It is recognized that fracture movement, leading to callus elongation and distraction, should not exceed 2% of the fracture gap size. If the amount of strain caused by fragment movement during physical exercise is higher, the initial microstructure of the bridging tissues is repeatedly disrupted. As a result, the contribution of the callus formation to stabilize the fracture is delayed.(14) For the distal humerus, biomechanically stiffer implants that prevent fragment movement are therefore thought to be favourable for osteosynthesis.(15, 16)

The search for more optimal fracture fixation methods that provide a higher degree of primary stability is therefore still ongoing. Improvements have been attempted by changing implant-design and configuration.

Clinical and biomechanical results have shown that double-plate osteosynthesis is the most feasible and stable method of osteosynthesis.(15, 17-19) The biomechanical behaviour of the osteosynthesis depends more on plate configuration than plate type. Most authors agree that plate positioning should be dorsal at the radial column and medial or dorsal at the ulnar column. Lateral plate positioning for reconstruction of the radial column, as previously recommended(20), might be difficult to achieve and restoration of the anatomical condylar-shaft angle is complicated.(12, 17)

It has also been proposed that the use of plates with angular stability impacts on the bone-implant interface behaviour during mechanical loading.(21, 22) It has been shown that failures by pull-out or cut-out of the implant are less likely to occur if implants with angular stability are used for osteosynthesis. This reduction in failure likelihood is explained by the reduction of localized stress-concentration at the bone-implant interface. Furthermore, pull-out forces are transferred into compression and shear forces between the screws and the adjacent osseous structures.(21)

However, it is known that the biomechanical behaviour of the osteosynthesis methods also depends on the fracture type and on the presence or absence of metaphyseal defects.(23) Taking our own experience, conventional reconstruction plates are still appropriate if the osseous blood supply is sufficient, good bone quality is present and the fracture type allows fracture fixation with cortical contact between the fragments. However, in humerus with decreased bone mineral quality or in the presence of a metaphyseal comminution, locking compression plate is the implant of choice.

Although dual plating is the preferred modality of surgical intervention in intercondylar distal humerus fractures, it has its own demerits in the form of pain, stiffness, nerve injury, infection, implant loosening, heterotopic ossification and delayed union.

Limitations of our study: As this was a descriptive study, due to the absence of a control or comparator group, it is difficult to make a definitive conclusion whether Dual plating is the best treatment option for the closed intercondylar distal humerus fractures or not. To make a definitive conclusion, a randomised controlled trial would be needed. Our sample size reflects the routine patient inflow in our hospital. A study with a larger sample size, would have made a better assessment of this surgical intervention.

Conclusion:

In our study, Good to Excellent results were seen in 80 % of the patients, of an average age of 39.6 yrs, with closed intercondylar distal humerus fractures (Riseborough and Radin type I to IV), according to Mayo Elbow Performance Score, at the end of 6 months.

Hence we conclude that Dual Plate technique provides good fixation for closed intercondylar distal humerus fractures if proper preoperative planning, good reduction and surgical technique are followed, leading to high rate of bone union and minimal soft tissue damage.

For intercondylar distal humerus, biomechanically stiffer implants that prevent fragment movement are therefore thought to be favourable for osteosynthesis.

The biomechanical behavior of the osteosynthesis depends more on plate configuration than plate type. Compared with parallel fixation, 90-90 perpendicular plate fixation had significantly greater torque to failure load. Both plating constructs are equally sensitive to bone density. Both techniques had the same mode of failure in torsion.

Taking our own experience, conventional reconstruction plates are still appropriate if the osseous blood supply is sufficient, good bone quality is present and the fracture type allows fracture fixation with cortical contact between the fragments. However, in humerus with decreased bone mineral quality or in the presence of a metaphyseal comminution, locking compression plate is the implant of choice.

The procedure provides stable fixation and allows early mobilization that in turn enhances the process of union, especially in closed intercondylar distal humerus fractures. However, functional outcome in fractures with severe osteoporosis varied.

Any defect in the articular surface should be filled with autogenous bone graft, because shortening of the trochlea will lead to incongruency and arthrosis of the ulnohumeral joint.

Most of the complications of Dual Plate technique are related to the operative technique, type of fracture, intraoperative reduction, physiotherapy, instruments and implant quality which can be brought down by proper preoperative planning.

Dual Plate technique requires a higher surgical skill, proper positioning of the patient, good fracture fragment orientation and reduction manoeuvre technique, good instrumentation and vigilant mobilization in the form of physiotherapy. The implants are comparatively expensive and it has a steep learning curve and should be used after proper training.

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