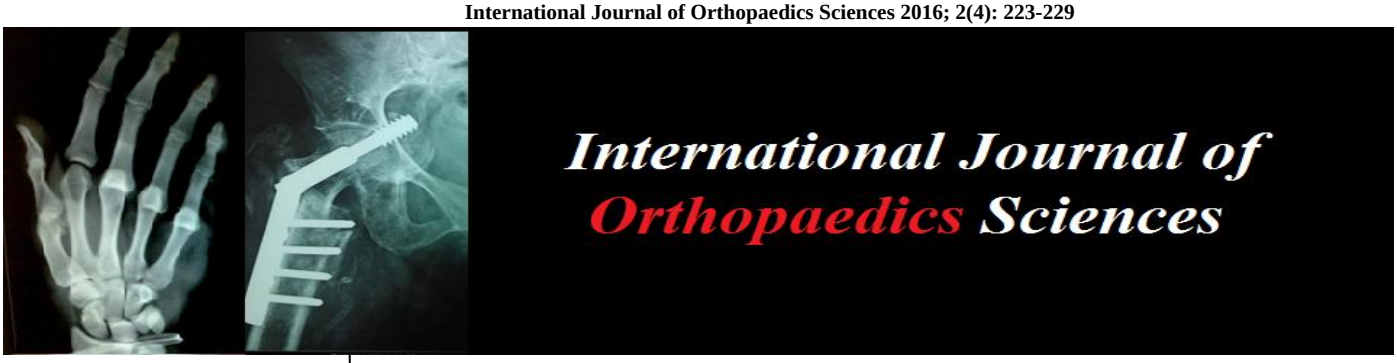


ISSN: 2395-1958
IJOS 2016; 2(4): 223-229

www.orthopaper.com
Received: 06-08-2016
Accepted: 07-09-2016

Dayanand BB
Associate Professor, Shri BM Patil Medical College Hospital and Research Centre, BLDE University, Vijayapura, Karnataka, India

Santosh S Nandi
Associate Professor, Shri BM Patil Medical College Hospital and Research Centre, Vijayapura, Karnataka, India

Tapan S Gupta
Shri BM Patil Medical College and Research Centre BLDE University Bangarama Campus Sholapur Road, Vijayapura, Karnataka, India

Amit Patel
Junior Resident, Shri BM Patil Medical College Hospital and Research Centre, BLDE University Vijayapura, Karnataka, India

Correspondence
Tapan S Gupta
Shri BM Patil Medical College and Research Centre BLDE University Bangarama Campus Sholapur Road Vijayapura, Karnataka, India

A prospective study of surgical management of distal end humerus fractures in adults

Dayanand BB, Santosh S Nandi, Tapan S Gupta, Amit Patel

DOI: http://dx.doi.org/10.22271/ortho.2016.v2.i4d.36

Abstract
Introduction: Distal humerus fractures are uncommon injuries that account for fewer than 2% of all adult fractures. The aim of the study is to evaluate the functional outcome of the surgical management of distal humerus fractures in adults treated by various methods using the post-operative functional criteria by Riseborough and Radin and the Mayo Elbow Performance Index (MEPI).
Materials and Method: A Prospective clinical study was conducted over a period of 4 years which included 93 patients in tertiary care centre. The patients were treated with primary open reduction and internal fixation using 3.5 mm reconstruction plates, 4 mm cannulated cancellous screws, bipillar plating using reconstruction plating, K-wires and Y plate or a combination of the above methods using a posterior approach.
Results: The average age of the patients in our study was 42.91 years with a range of 18-72 years. In our series, according the Riseborough and Radin criteria, the results were Good in 55(59.13%) patients, Fair in 32(34.4%) and Poor in 6(6.45%) patients. According to MEPI, we had Excellent results in 20(21.5%), Good in 43(46.2%), Fair in 25(26.8%) and Poor in 5(5.37%) patients.
Conclusion: Operative treatment with rigid anatomical internal fixation should be the first line of treatment for all grades of Riseborough Radin intercondylar fractures, more so in young adults as it gives best chance to achieve good elbow function. Vigorous, active physiotherapy is a must for good results. Stable fixation allows early, active and aggressive post-operative mobilization.

Keywords: Distal humerus, plate osteosynthesis, MEPI

1. Introduction
Distal humerus fractures are uncommon injuries that account for fewer than 2% of all adult fractures. The complex shape of the elbow joint, the adjacent neurovascular architecture, and the sparse soft tissue envelope combine to make these fractures difficult to treat. Acceptable results have been reported in a majority of patients treated by open reduction and internal fixation [1]. Restoration of painless and satisfactory elbow function after a fracture of the distal humerus requires anatomic reconstruction of the articular surface, restitution of the overall geometry of the distal humerus, and stable fixation of the fractured fragments to allow early and full rehabilitation [2]. Depending upon the frequency of comminution and displacement, open reduction and internal fixation with Y plate, reconstruction plate, bipillar anatomical plating, 'K' wire and double tension band wiring can be done individually or in combination. These fractures remain as challenges to effective treatment and are best managed by the surgeon's interest and experience in skeletal trauma involving the upper extremity. However, even the most experienced surgeons may be intimidated with certain fracture characteristics, including: poor bone quality, fracture involving the distal most aspects of the bone columns, and fragmentation of the articular surface in sagittal and coronal planes. A surgeon treating a healthy, active patient with a fracture of the distal humerus should make every attempt to reconstruct and preserve the bone [3].

The final X-ray does not always coincide with the functional result (Keon-Cohen). Those with Excellent function of the elbow may demonstrate a distorted radiographic appearance, and vice versa. On final X-ray, there may be nearly perfect anatomical restoration but poor functional capacity, usually due to joint stiffness (Riseborough) [4]. Hence the surgeon may have to compromise appearance (both clinically and radiographically) for function [5]. The aim of the present study is to evaluate the functional outcome of surgical management of distal humerus fractures in adults treated by various methods using the post-operative functional criteria by Riseborough and Radin [4] and the Mayo Elbow Performance Index (MEPI) [6].

2. Materials and Methods

This study was conducted over a period of 4 years and included 93 patients. Patients admitted to the hospital with a diagnosis of distal end humerus fracture, willing to undergo surgical treatment, and participate in the study were included. Patients with compound fractures of the distal humerus, patients less than 18 years of age, and patients medically unfit for surgery were excluded from the study. Written informed consent was obtained from every patient regarding the surgery and inclusion in the study. The patients were evaluated using a standardized pre-anaesthetic work-up, and other associated injuries were treated using the appropriate treatment for that particular disease.

Surgery was performed either under general anaesthesia (32 patients) or under brachial block (61 patients). The patients were treated with primary open reduction and internal fixation using 3.5 mm reconstruction plates, 4 mm cannulated cancellous screws, bipillar plating using reconstruction plating, K-wires and Y plate or a combination of the above methods. Posterior approach (Campbell's) was used in all patients using either a triceps splitting, olecrenon osteotomy or a TRAP procedure under tourniquet control. None of the patients underwent primary elbow replacement. No patient had a history of inflammatory arthritis or other arthritis of the injured elbow.

Fragments of the humerus were assembled in 3 steps –

1. Reduction and fixation of condyles together
2. If fractured, the medial or lateral epicondylar ridge was fixed to the humeral metaphysis
3. Reassembled condyles were fixed to the humeral metaphysis.

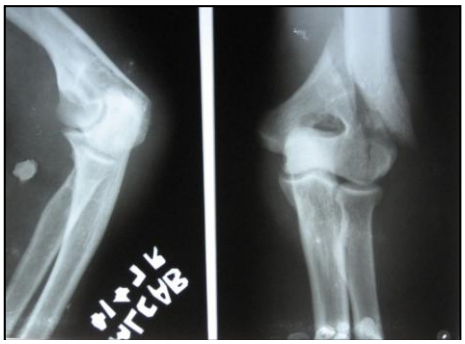
Post-operatively, patients were instructed to keep the limb elevated and move their fingers actively. Suction drain was removed after 24-48 hours. Wound was inspected after 3-4 days. IV Antibiotics were given to the patient for 3-5 days, later converted to oral until suture removal. Sutures were removed on the 12th postoperative day and check X-ray in antero-posterior and lateral views were obtained.

Patients were later discharged with the above elbow posterior POP slab and advised to perform active shoulder and finger movements. Patients were advised not to lift heavy weight or exert the affected upper limb.

Upon discharge, patients were advised to report for follow up after 3 weeks. The posterior POP slab was then removed, an arm pouch was given and the patient was advised to do an active range of elbow movements as the pain permits. Patients were asked to return at 6 weeks, 12 weeks and thereafter every 6 months. The results were assessed at 3 months, 6 months and 1 year after the procedure. At follow up, a detailed clinical examination was done and patients were assessed subjectively for the symptoms like pain, swelling and restriction of joint motion. Patients were instructed to perform physiotherapy in the form of active flexion-extension and pronation-supination without loading.

The functional assessment of the patient was done according to the Riseborough and Radin grading system and the Mayo Elbow Performance Index.

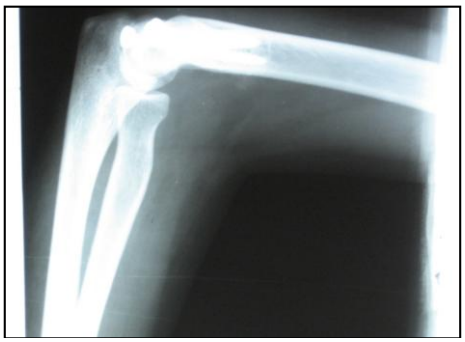
Case 1



Pre-Operative

Post-Operative

After 6 Weeks



Union after 15 Weeks

Case 1

Flexion

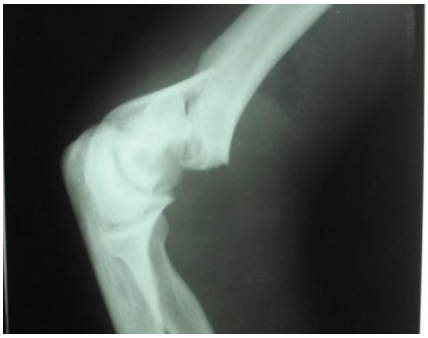
Extension

Supination

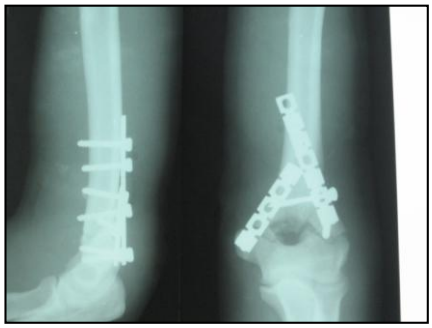
Pronation

Case 2

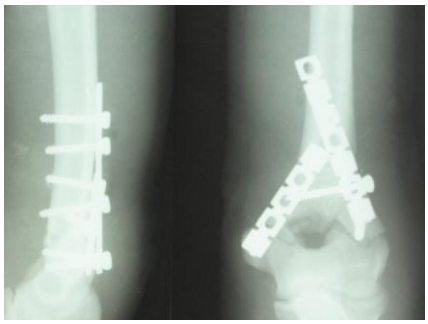
Pre-Operative



Pre-Operative



Post-Operative



After 6 Weeks

Case 2

Flexion

Extension

Supination

Pronation

Case 3

Pre-Operative

Post-Operative

After 6 Weeks

After 3 Months

Case 3

Flexion

Extension

Supination

Pronation

3. Results

The average age of the patients in our study was 42.91 years with a range of 18-72 years. 64 male patients with 29 female patients participated in the study; the male-to-female ratio was 2.2. The side involvement was almost equal with 47 fractures on the left side and 46 on the right. The fractures of the distal humerus were classified according to the Riseborough and Radin classification. We had 16(17.2%) patients with type 1 fractures, 32(34.4%) with type 2, 32(34.4%) with type 3 and 13(14%) with type 4 injuries. The average follow-up was 15.3 months with a range of 12-22 months (Table I).

Table I: Range of follow-up in months with the number of patients for each category.

Range in months	No. of Patients
12-14	30
15-17	33
18-20	26
21-22	4

Out of the 93 patients, 5(5.3%) had hypertension, 5(5.3%) had diabetes and 3(3.22%) had both hypertension and diabetes which were treated pre-operatively with the help of physicians. 3 patients had distal radius fractures which were treated with percutaneous pinning and casting at the same time as the surgery for distal humerus. Two patients had associated femoral shaft fractures and two had tibial shaft fractures; they were treated with intramedullary interlocking nailing, but at a different sitting.

3 patients had radial shaft fractures treated at the same sitting with DCP plating. The post-operative protocol was almost the same except the pronation/supination exercises were delayed.

Four different treatment procedures were done in the 93 patients. 7(7.52%) patients were treated with cancellous screw and k-wire fixation, 44(47.31%) with cancellous screw and reconstruction plating, 29(31.1%) with bipillar plating and 13(13.97%) patients with Y plating. The distribution of the type of fractures and type of treatment are included in the Table II.

Table II: Showing distribution of fracture type with various treatment modalities. BP: Bipillar Plating, CCK: cc screw & k-wiring, CCR: cc screw & k-wiring, CCY: y- plate with cc screw.

Fracture Type	Treatment				Total	Percentage (%)
	BP	CCK	CCR	CCY		
1		7	9		16	17.2
2			32		32	34.4
3	19		3	10	32	34.4
4	10			3	13	14

The final results were classified according to the Riseborough and Radin criteria and the Mayo Elbow Performance Index (MEPI). In our series, according the Riseborough and Radin criteria, the results were Good in 55(59.13%) of patients, Fair in 32(34.4%) and Poor in 6(6.45%). According to MEPI, we had Excellent results in 20(21.5%), Good in 43(46.2%), Fair in 25(26.8%) and Poor in 5(5.37%) patients. Thus, in the Riseborough and Radin criteria, we achieved good to fair results in 87(93.54%) of patients. According to MEPI, we obtained excellent to fair results in 88(94.62%). The distribution of results according to the fracture types is shown in Table III.

Table III: type of fractures and results.

Type of Fracture	Riseborough and Radin Criteria			MEPI			
	Good	Fair	Poor	Excellent	Good	Fair	Poor
1	16(17.2%)			10(10.7%)	6(6.45%)		
2	21(22.5%)	11(11.8%)		9(9.6%)	17(18.2%)	6(6.4%)	
3	17(18.2%)	14(15.05%)	1(1.07%)	1(1.07%)	19(20.4%)	11(11.8%)	1(1.07%)
4	1(1.07%)	7(7.52%)	5(5.37%)		1(1.07%)	8(8.6%)	4(4.3%)

Most of the good results were seen in type 1 and 2 fractures while the poor results were seen in type 4. Results according to the type of surgery are shown in Table IV.

Table IV: results according to type of surgery done.

Treatment	Result (Riseborough and Radin)			Mayo Elbow Performance Index			
	Good	Fair	Poor	Excellent	Good	Fair	Poor
Bipillar Plating	12(12.9%)	13(13.9%)	4(4.3%)	1(1.07%)	13(13.9%)	11(11.8%)	4(4.3%)
Cc Screw & K- Wiring	7(7.5%)			4(4.3%)	3(3.2%)		
Cc Screw & Recon Plating	32(34.4%)	12(12.9%)		15(16.1%)	22(23.6%)	7(7.5%)	
Y Plate With Cc Screw	4(4.3%)	7(7.5%)	2(2.1%)		5(5.3%)	7(7.5%)	1(1.07%)

The most common complication in our series was post-operative stiffness of the elbow, seen in 8 patients (8.6%). The second most common complication was superficial infection seen in 5(5.3%) patients. The other complications in our series were deep infection in 3(3.2%) patients, non-union in 2(2.1%) and implant failure in 2(2.1%) patients. Stiffness was treated with physiotherapy in the form of CPM and ROM exercises, but for some stiffness persisted and led to poor results according to the final score. The superficial infections were treated by a change in antibiotics and patients recovered without any long term complications.

Deep infections seen in patients were treated aggressively with debridement and antibiotics but the implants were not removed. The patients recovered with some stiffness but there were no cases of osteomyelitis seen during follow-up. Non-union and implant failure were treated with the changing of the implant with rigid fixation and a bone graft from the iliac crest. Union was seen in cases of non-union and implant failure on follow-up after second surgery.

4. Discussion

Intra-articular distal humeral fractures require open reduction and internal fixation of the medial and lateral columns as well as the articular surface depending on the type of fracture and communition present [7]. The optimal approach for ORIF of distal humerus fractures is one which provides adequate

exposure with minimal soft tissue damage. There has been debate about the most appropriate procedure, with controversy as to which is the best, each with its own advantages and disadvantages [8-10].

An olecranon osteotomy approach has been the gold standard for distal humeral exposure [11]. Regardless of the method of treatment, substantial damage to the distal humerus usually results in some limitation of motion, pain, weakness, and possibly instability. Even minor irregularities of the joint surface of the elbow can cause some loss of function. This can typically be minimized by early, accurate open reduction with sufficiently rigid fixation to permit immediate motion [10].

The average age in our study was 42.91 years. This was comparable with other series such as Gabel [12] *et al* and Kun-Chuang Wang [13] *et al* which had an average age of 45 and 47 years respectively. The general characteristics of the patients have been shown in Table V.

Table V: Demographic parameters of the study.

General Characteristics	Value
Average Age	42.91 yrs
Male: Female ratio	2.2
Left: Right	47:46
Most Common mode of injury	Road traffic Accident
Most common fracture type	Type 2 and 3 (32 each)
Average Follow-up	15.3 months
Most common Complication	Stiffness (8.6%)
Excellent to Good results(MEPI)	67.7%

According to Mayo Elbow Performance Index [14], we had Excellent results in 20(21.5%), Good in 43(46.2%), Fair in 25(26.8%) and Poor in 5(5.37%) patients, and Excellent to Good results in 63(67.7%). In a study done by Erpelding [14] *et al*, they had Excellent results in 15(62.5%), Good in 7 (29.1%) and Fair in 2(8.3%) with no poor results. This difference might be due to the large sample size with different surgical approaches used in our study. Erpelding *et al* used an extensor on mechanism for fixation of fractures. A study by Aslam [15] *et al*, found fourteen patients (70%) had an Excellent or Good outcome, five patients (25%) a Fair outcome and one patient (5%) had a Poor result. These results were comparable to our study.

We compared the results of our study according to the Riseborough and Radin criteria according to the original study done by the same authors. In our study, the results were Good in 55(59.13%) of patients, Fair in 32(34.4%) and Poor in 6(6.45%) patients. According to the original study, they obtained Good results in 10 (35.7%), Fair in 10(35.7%) and Poor in 8(28.5%) [16] Of patients. Our results were likely more favorable due to advances in fixation and operative techniques.

8(8.6%) patients had wound infections, of which 3 were deep and required open debridement. A study done by Huang *et al* [17], had reported wound infection in 5% of the patients. Another study by Henly *et al* [18], found infections in 4% of patients. The reported complications in our series were similar to the reported literature. We had a reported incidence of non-union and implant failure in 2.1% of patients in our study. Patients with non-union were treated with removal of hardware, freshening up the edges and internal fixation with cancellous iliac graft. Implant failure was treated in a similar fashion. The reported complications in the series by Henly [18] were 2% and 5% for non-union and implant failure respectively.

No cases of neuropathy were seen in our series. All cases showed radiological union in the final follow-up.

Our study had its limitations. First, the average follow-up was only 15.3 (Table V) months and long term follow-up was not available. Second, comparison between different treatment groups could not be done as the study was not randomized and treatment was individualized according to the needs and financial situation of the patient.

5. Conclusion

Fractures of the distal humerus often produce extensive soft tissue injury in addition to the bony injury. Preoperative roentgenograms should be carefully evaluated, and appropriate treatment should be instituted as soon as possible. If open reduction is delayed by indecision or follows the failure of closed methods, the best time for surgery may be lost and soft tissue contractures, myositis ossificans, and a more difficult reconstructive procedure are more likely. Regardless of the method of treatment, substantial damage to the distal humerus usually results in some limitation of motion, pain, weakness, and possibly instability. Even minor irregularities of the joint surface of the elbow can cause some loss of function. This can usually be minimized by early, accurate open reduction with sufficiently rigid fixation to permit immediate motion.

Operative treatment with rigid anatomical internal fixation should be the line of treatment for all grades of Riseborough Radin intercondylar fractures, more so in young adults as it gives best chance to achieve good elbow function.

Vigorous, active physiotherapy is a must for good results. Stable fixation allows early, active and aggressive postoperative mobilization.

6. References

1. Kuntz JR, David G, Baratz Mark E. Fractures of the elbow. Orthop Clin North Am. 1999; 30(1):37-61.
2. O'Driscoll W, Joaquin S, Michael E. Management of the smashed distal humerus. Orthop Clin North Am. 2002; 33(1):19-33.
3. Holdsworth BJ, Mossad MM. Fractures of the adult distal humerus: Elbow function after internal fixation. J Bone Joint Surg Br. 1990; 72B:362-368.
4. Riseborough EJ, Radin EL. Intercondylar T fractures of the humerus in the adult. A comparison of operative and non-operative treatment in twenty nine cases. J Bone Joint Surg. 1969; 51A:130-141.
5. Cohen BT. Fractures and the elbow. J Bone Joint Surg. 1993; 48A:1623-1639.
6. Longo U, Franceschi F, Loppini M. Rating systems for evaluation of elbow. British Medical Bulletin. 2008; 87:131-61.
7. Sanchez-Sotelo J, Torchia ME, O'Driscoll SW. Complex distal humeral fractures internal fixation with a principle-based parallel-plate technique. J Bone Joint Surg Am. 2007; 89:961-9.
8. Anglen J. Distal humerus fractures. J Am Acad Orthop Surg. 2005; 13:291-7.
9. Bryan RS, Morrey BF. Extensive posterior exposure of the elbow. A triceps-sparing approach. Clin Orthop Relat Res. 1982; 166:188-92.
10. Canale ST, Beaty JH, editors. Campbell's operative orthopaedics. 11th ed. Philadelphia: Mosby, 2008.
11. Gofton WT, Macdermid JC, Patterson SD. Functional outcome of AO type C distal humeral fractures. J Hand Surg Am. 2003; 28:294-308.
12. Gabel G, Hanson G, Bennett J. Intraarticular fractures of the distal humerus in the adult. Clin Orthop & Related Research. 1987; 216:99-108.

13. Wang K, Shih H, Hsu K. Intercondylar fractures of the distal humerus: routine anterior subcutaneous transposition of the ulnar nerve in a posterior operative approach. J of Trauma. 1994; 36(6):770-773.
14. Erpelding J, Mailander A, High R. Outcome following distal humeral fracture fixation with an extensor mechanism-on approach. JBJS Am. 2012; 94:548-53.
15. Aslam N, Willett K. Functional outcome following internal fixation of intraarticular fractures of the distal humerus (AO type C). Acta Orthop Belq. 2004; 70(2):118-22.
16. Riseborough EJ, Radin EL. Intercondylar T fractures of the humerus in the adults. J Bone Joint Surg Am. 1969; 51:130-138.
17. Huang T, Chiu F, Chuang T. Surgical treatment of acute displaced fractures of adult distal humerus with reconstruction plate. Injury. 2004; 35(11):1143-8.
18. Henly Bradford M. Intra-articular distal humeral fractures in adults. Orthop Clin North Am. 1987; 18(1):11-23.