Original paper

Open Reduction and Internal Fixation Compared to Closed Reduction and External Fixation in Distal Radial Fractures Arandomized Study of 40 Patients

Diaa Gafar Sadik[1*], Zaid Abdali[1]

[1]Alkhadimia teaching Hospital, Baghdad, Iraq

Abstract

Objective: to investigate if open reduction and internal fixation would produce better outcome than external fixation of distal radial fractures.
Patients and Methods: 40 patients with unstable or comminuted distal radial fracture where divided randomly into two groups using 2 methods of treatment, in group one closed reduction &bridging external fixation was used ,in group tow open reduction &internal fixation was used. The primary outcome parameter was grip strength, but the patients were followed for 1 year with objective clinical assessment, subjective outcome and radiographic examination.
Results & Discussion: At one year postoperatively , grip strength was 89%(standard deviation 15) of the injured side in the internal fixation group and 75%(15) in the external fixation group. Pronation /supnation was 150 (15)in the internal fixation group &136 in(20) in the external fixation group at 1year.4 patients in the external fixation group where reoperated due to malunion as compared to 2 in internal fixation group.6 others are classified as radiographic malunion, 5 in the external fixation ,1 in the internal fixation group.
Conclusion: internal fixation gave better grip strength &and better range of motion at one year, and less malunion than external fixation. No difference could be found regarding subjective outcome.
Key words: distal radial fracture, internal fixation, external fixation.

Introduction

**Will at some remote period again enjoy perfect freedom in all of its motions and be completely exempt from pain* "Abraham colles 1814 (1)

The management of distal radial fractures has changed significantly since Colles proclamations in 1814.Although distal radial fractures account for up to 20% of all fractures treated in the emergency department; many are not completely exempt from pain after treatment. Yet there is no consensus on which treatment is superior or firm guidelines on treatment decision.

Many confounding variables exist, all of which are somewhat controversial; the level to which the anatomy is restored, the quality of bone, the emergence of new techniques devices, the experience & ability of the surgeon, and outcome in older populations. The desire for anatomical restoration of the distal radial joint often is the rational for operative treatment.

Many studies have associated as little as 1 mm of incongruity of the articular surface with worse outcomes; whereas other reports have found no association between radiographic arthrosis and outcomes.

Complicating the matters further is the fact of bimodal distribution of patients; do the young &elderly fare differently? Multiple recent reports indicate that older, low demand patients tend to tolerate, incongruity, deformity and malunion well.

*For Correspondence: Email to diaa.gafar@yahoo.com

However, Madhok et al. noted that in elderly patients treated none operatively 26% reported functional impairment. Essentially, we know that elderly patients will tolerate more displacement (and closed treatment) than younger patients, but some still have poor outcome. What is unknown is who would benefit from operative anatomical restoration. High demand patients represent only a small percentage in most series, and although most patients do well, restoration of the distal radial anatomy is believed to be essential to minimize the complications of arthrosis & functional impairment in these patients. Bone quality also is a confounding variable in trying to determine the best treatment for a particular patient. Bone quality is directly related to the ability to obtain and maintain reduction. In patients with poor bone quality, low-energy trauma may produce significant displacement and commination. Ketter et al. suggested that osteoporosis should be included in classification systems for distal radial fractures.

One constant in the recent literature is that the specific technique is not as important as attaining anatomical reduction. Both clinical outcome and biomechanical studies demonstrate that maintenance of palmar tilt (normally 11 degrees), of ulnar variance (normally −2 mm), and of radial height (normally 12 mm) is the most important factor in obtaining good results. Numerous techniques are available (e.g., *closed reduction and percutaneous pinning, external fixation, dorsal plating, volar locked plating, intramedullary nailing*), each with its specific complications and learning curve.

Because of the unanswered questions concerning the treatment of distal radial fractures in a heterogeneous group of patients, treatment must be individualized for each patient based *on expectations, demand level, age, bone quality, fracture characteristics, and surgeon experience and ability*[(1)]

Epidemiology

Distal radius fractures are among the most common fractures of the upper extremity. More than 650,000 occur annually in the United States. Fractures of the distal radius represent approximately one-sixth of all fractures treated in emergency departments.

The incidence of distal radius fractures in the elderly correlates with osteopenia and rises in incidence with increasing age, nearly in parallel with the increased incidence of hip fractures.

In males aged 35 years and older, the incidence is approximately 90 per 100,000 population per year and remains relatively constant until the age of 70 where a slight increase is seen.

Risk factors for fractures of the distal radius in the elderly include decreased bone mineral density, female sex, white race, family history, and early menopause [(2)]

Patients & Methods

40 patients mean age 48 (20–65) years, 26 women 14 men with primarily irreducible, unstable, or comminuted distal radial fractures were randomized between May 2007 and December 2012 to be operated with either open surgery using the small T buttress plate or closed surgery. The surgery was performed by 4 orthopaedic surgeons. The study was conducted in Alkhadimia teaching hospital. Patients were divided randomly into two groups. First group treated by open reduction &internal fixation, second group treated by closed reduction& external fixation. At our department, all patients with a distal radial fracture treated according to a treatment protocol. Non-displaced fractures are treated in a plaster cast for 4–5weeks. Displaced fractures are reduced and casted. If the fracture after reduction is unstable or even impossible to primarily reduce surgical treatment is suggested to the patient.

Table 1. The inclusion and exclusion criteria for the study

Inclusion criteria
*Age 18–65
*Frykman type I–VIII fracture impossible to reduce or retain in an acceptable position in cast after closed reduction.
*Injury less than 10 days.
*Incongruence in RC-or DRU-joint and/or axial compression > 2mm, and/or dorsal angulation > 20°
Patient had received oral and written information and signed an informed consent
Exclusion criteria
*Previous ipsilateral fracture
*Volarly displaced fracture
*Fracture in the contralateral side, or other fracture in need oftreatment
*Open fracture
*ongoing radiotherapy or chemotherapy
*Metabolic disease affecting the bone
*Medication affecting the bone
*Dementia, psychiatric disorder, or alcohol abuse

Between May 2007 and December 2012, 40 patients (26 women) and (14 men) with a mean age of 48 (20–65) years with unstable fractures fulfilled the inclusion criteria (Table 1). Most patients with a distal radius fracture were older than 65 years and were not eligible for the study. Patients with a dislocated fracture were also not eligible for the study. Thus, only younger patients with an unstable fracture who were in need of an acute operation were recruited, thus explaining the relatively long recruitment time. The patients gave their written and informed consent, and were included and randomized to either open reduction and internal fixation (O), or closed reduction and external fixation(C). 40 patients considered to be healthy, 5 had cardiovascular diseases such as hypertension or atrial fibrillation,3 had diabetes mellitus, 2 had epilepsy, 1 had hypothyroidism,1 had well-controlled depressive problems, and 3 had asthma.

All patients were followed for 1 year with visits at 2, 5, and7 weeks and 3, 6, and 12 months postoperatively. The grip strength at 7 weeks and at 12 months was chosen as the primary outcome. Reoperations for either a malunion or a redisplacement of the fracture were considered to be endpoints and patients were excluded thereafter. Complications were registered by orthopaedic surgeon at each visit.

Complications were divided into (1) major complications,defined as those that were expected to have an effect on the final outcome, (2) moderate complications, defined as those that were not expected to have an effect on the final outcome but would need further intervention 3 minor complications; defined as temporary and self-healing.

Grip strength (JAMAR), **range of motion** (goniometer), and **sensibility** in all fingers (Weber 2PD) were recorded at all visits. Lateral and anteroposterior radiographs were taken at injury, directly postoperatively, at 2 and 5 weeks, and at 3, 6, and 12months postoperatively.

Operative technique:

The patients were operated by 1 of 4 orthopaedic surgeons. The participating surgeons agreed to aim for the best possible stabilization in each patient with each technique, including the use of additional K-wires, bone graft, or bone substitute.

Open reduction and internal fixation (O): through volar skin incision,going through the sheath of flexorcarpi radialis, sweeping the flexorpollices longus with index finger and using the freer elevator the pronator quderatous removed, the fracture exposed, redaction by traction and K wire as lever

was done then application of volar normal plate fixed by at least 4 screws,repeated checking by C ARM radiography was used,closure of the wound in layers and volar slab replaced by wrist orthosis for 6 weeks.

Closed reduction and external fixation (C):

The external fixator used for the first 20 patients was the Hoffman type-1 bridging external fixator (Stryker, Hopkinton, Pins were inserted into the second metacarpal and into the radius proximally to the fracture. Clamps were attached to the pins and the fracture was reduced and fixated with a steel rod between the clamps. In comminuted fractures with a bone defect and when additional stability was desired, K-wires were inserted percutaneously. The fixator was usually removed after 5–6 weeks and thereafter active mobilization was started under the supervision of a physiotherapist.

There was no restriction regarding pronation or supination during the fixation time in either of the two groups.

Results

-Age, sex, injured side, type of work,category of fracture, radiographic findings, and type of injury were equally distributed between the groups...

- Most patients had intraarticular fractures, either in the radiocarpal joint or in the distal radioulnar joint or both, and only 8 patients had extraarticular fractures.

-There were 4 AO type-A fractures in each group, and 20 type-C fractures in the C group and 22 in the O group.

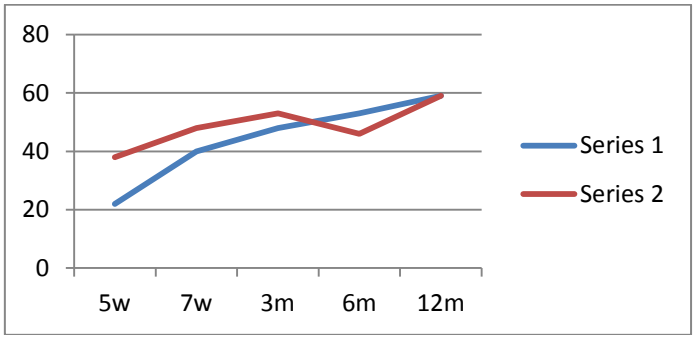
-The operations were performed ata mean time of 3.6 (1–9) days after injury.

- In 7 patients in the C group,the fracture was augmented with K-wires.And the fixator was kept on for 36 (33–41) days,There were noperoperative complications.

-Postoperatively, the patients in the open group were treated in a forearm plaster cast for 14 (6–20) days.

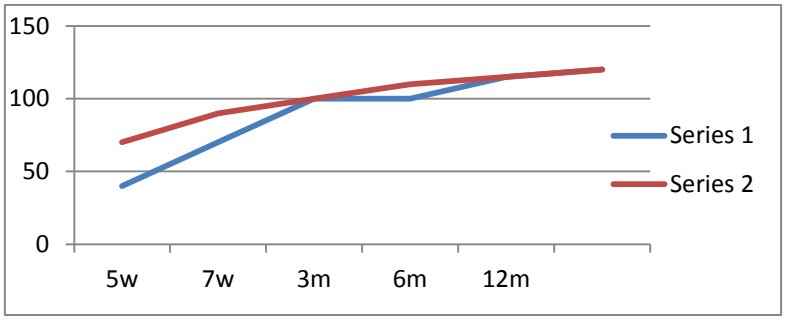
-At 7 weeks postoperatively, the primary outcome parameter, mean grip strength, was significantly higher in the O group than in the C group (47%of the injured side and 34% of the injured side, respectively) (p =0.01). Also, the mean range of motion in forearm rotation was significantly greater in the O group than in the C group (129° and 104°, respectively) (p = 0.006). No statistically significant differences were found regarding extension/flexion (88° and 74°, respectively) (p = 0.09) or radial/ulnar deviation (48° and 41°) (p = 0.2) at the early follow-up. At the final follow-up 1 year postoperatively, a statistically significant difference was still found between the O and C groups both regarding the primary outcome parameter grip strength (90% and 78%, respectively) (p = 0.03) and also forearm rotation (149° and 136°, respectively) (p = 0.03).

In both groups, range of movement in extension/flexion was 121° and in radial/ulnar deviation it was 60°.



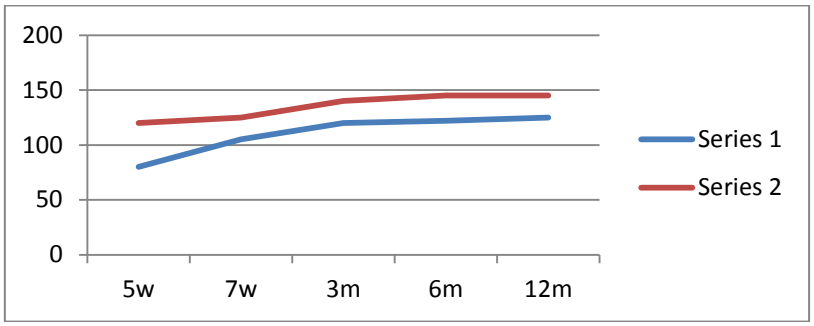
ROM in extension-flexion

Graph 1



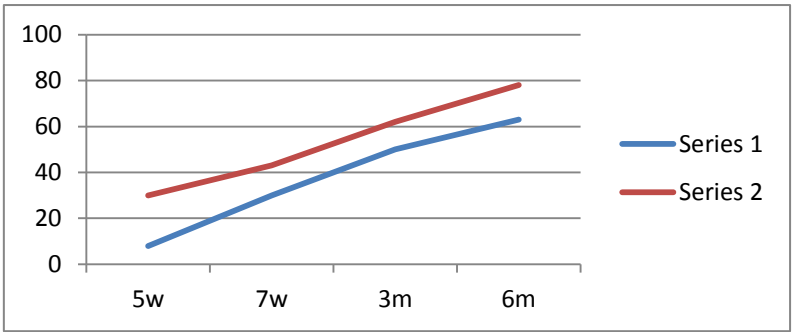
ROMin pronation –supination

Graph 2



ROMinpronation_supination

Graph 3



Grip strength(%)

Graph 4

Discussion

Distal radial fractures are most common fractures of the upper limbs and account for approximately 20% of all fractures, large percentage of these injuries occur in older women with osteoporosis. Despite the myriad of treatment options ,restoration of painless function of the injured wrist remain the ultimate goal. Plain radiograph (PA, true, fossa lateral, & oblique views)are usually sufficient to assess the initial displacement, angulation, and articular involvement. A CT scan if needed, may be helpful in delineating the extent of articular disruption.

The management of distal radial fractures should be individualized on the basis of fracture pattern, degree of displacement, other associated injuries, the patients activity level, and the surgeon experience and preference.

Despite the enthusiasm for internal fixation, closed reduction &immobilization should be attempted for most distal radial fractures that have minimal metaphyseal comminution and articular incongruity. Surgery is generally

indicated for fractures that are, unstable, have 2mm or more of articular displacement or those that are a part of mulitrumatic injury.

The advantage of closed reduction and casting of distal radial fractures is its non-surgical nature, however, there is a known risk of secondary displacement (up to 89% in patients older than 65 years) as seen on radiographs. Predictors of redisplacement include increasing age, metaphyseal comminution, and shortening at presentation. In older patients some degree of malalignment of the distal radius is well tolerated, several studies found no relationship between anatomic position at healing and functional outcome. [3] Non-operative treatment using plaster cast is chosen in no displaced fractures and in displaced, but reducible fractures(4) .

In contrast to many other fractures, there are having been a number of randomized studies on treatment of distal radial fractures. However, no clear conclusions can be drawn from meta-analyses of all randomized radial fracture studies as summarized in the Cochrane report [5] where 48 randomized trials and 25 different treatment options were compared in 3,371 patients.

Also, in a major meta-analysis [6] of 46 non-randomized studies with either external or internal fixation in 1,519 patients, no clear conclusion could be drawn. Finally, in addition to the lack of consensus regarding the older established methods, no randomized or high-quality prospective non-randomized studies have been carried out yet for the newest concepts.

-To our knowledge, 4 randomized studies have compared open reduction and internal fixation to closed or indirect reduction. In a recent study l [7], a better result was found for internal fixation with AO plates either dorsally or volarly compared to bridging external fixation with augmentation with Kirschner wires at the surgeon's discretion.

The other 3 studies have reported either an absence of significant differences or a better functional outcome for external fixation. [8-10] .A study concluded that open reduction and internal fixation provide the best articular anatomy in highly comminuted fractures, although the best outcome was achieved with the external fixator. [8] Other study compared internal fixation using the Dorsal Pi-plate with mini-open reduction and external fixation, and found a higher complication rate for the Pi-plate. A better grip strength was found in the mini-open group but there were no significant differences in ROM.[9].

A randomized 179 patients between either a mini-open indirect reduction and K-wires/screws or a full arthrotomy with internal fixation. A better result was found for the indirect group, but a high rate of crossovers from the indirect group to the open group at the time of surgery was reported and many patients were lost to follow-up. [10] Other study also found a higher complication rate for internal fixation with a dorsal plate than for external fixation.[9]

Higher rates of infection and hardware failure have been reported in patients treated with external fixation and higher rates of tendon complications with internal fixation [6]. Thus, in the literature as well as in our study, the patterns of complications differ between the methods and might help the orthopedic surgeon to decide whether to use external or internal fixation. We found a high rate of complications, but most were minor and transient. In the external fixation group, the rate of major complications such as redislocation requiring reoperation or complex regional pain syndrome was higher. Other studies have reported complication rates of20% and 85% with external fixation [11], [12], most complications being minor. The malunion rate is an important outcome variable when evaluating different surgical treatments, and should be included in the overall decision. In our study, *5 cases in*

the external fixation group and 1 case in the internal fixation group had loss of reduction and malunions requiring further surgery. 5 other patients in the C group and 2 in the O group had radiographic malunion only. The malunion rate found by comparing non-bridging external fixation to bridging external fixation, was similar to ours: 14 in the 30 patients treated with bridging external fixator.[13]

Regarding grip strength, which was the primary outcome in the power analysis, the group that was operated with internal fixation had a better result, may be less surprising, at 7 weeks, but more important also at 12 months. Also, regarding forearm rotation, the results were better in the internal fixation (O) group at all follow-up visits. The absolute values of grip strength and range of motion in the present study were similar to those in other studies, both in the C group [14-17] and in the O group, and in the latter case both comparing to the TriMed system [18,19] or to the latest fixation trends of angle-stable volar plating [20],[16].

There may be different explanations for the increased range of motion and grip strength in the internal fixation group after1 year of follow-up. The fractures in the O group might be better aligned at surgery and/or a better reduction may be maintained during the healing, leading to a better congruency of the joint. In the O group rehabilitation starts 3 weeks earlier, which could explain the early difference between the groups, both regarding range of motion and grip strength, as found in previous studies[21]. However, in the present study, this effect persisted throughout the whole of the first year. Also, regarding the subjective outcome there was a tendency for there to be a better outcome in the O group. This subjective outcome in both groups must be considered favorable, bearing in mind that in our study internal and external fixation was compared in the most unstable distal radial fractures. IN this group of patients with primarily unstable fractures, there is no acceptable alternative to surgery. Overall, considering the subjective and objective results as well as the rate of major complications and the sick-leave, we believe that internal fixation gives a superior result and in our opinion it would be the method of choice; however, results for the external fixator are still acceptable. Which method to use to internally stabilize the fracture is still a matter for discussion and should be the subject of future randomized studies. With smaller and smaller differences between the 2 methods, better and more sensitive subjective outcome instruments will be required if the number of patients needed to show a difference is to be kept within reasonable numbers.

Conclusion

The surgical treatment of distal radial fractures has become common, although, conclusive scientific evidence of improved patients outcome is lacking.

Surgical fixation is typically recommended for fractures with radial shortening of more than 3mm, dorsal tilt greater than 10 degree, or intra articular displacement of more than 2mm.

Closed management or percutaneous pinning alone has worse radiographic outcome than external fixation augmented with percutaneous pins.

Internal fixation yields radiographic and clinical results that are at least comparable with augmented external fixation. Because internal fixation produces radiographic results comparable to external fixation, internal fixation can be expected to provide radiographic results that are better than those of casting or percutaneous pinning.

The trend in surgical fixation is away from percutaneous pinning ,and external fixation and toward internal fixation.

Fractures of the distal radius like other periarticular fractures , are best treated by internal fixation that is sufficiently stable to allow immediate active motion of the

wrist while maintaining alignment. Internal fixation ,especially with volar fixed angle plate is seemingly the preferred treatment for most displaced or unstable distal radial fractures .

Internal fixation gave better grip strength and better range of motion at one year, and tend to have less malunion than external fixation. No difference could be found regarding subjective outcome.

References

1. Campbells operative orthopaedic 12th edition 2013 by S.Terry Canale &James H.Beaty.
2. Handbook of fractures 4th edition 2010 by Kenneth Egol.
3. Orthopaedic knowledge update 10 2011 american academy of orthopaedic surgeon.AAOS.
4. Handoll H H, Madhok R. Conservative interventions for treating distal radial fractures in adults. Cochrane Database Syst Rev 2003a; CD000314.
5. Handoll H H, Madhok R. Surgical interventions for treating distal radial fractures in adults. Cochrane Database Syst Rev 2003b; CD003209.
6. Margaliot Z, Haase S C, Kotsis S V, Kim H M, Chung K C. A meta-analysis of outcomes of external fixation versus plate osteosynthesis for unstable distal radius fractures. J Hand Surg (Am) 2005; 30 , 1185-99.
7. Leung F, Tu Y K, Chew W Y, Chow S P. Comparison of external and percutaneous pin fixation with plate fixation for intra-articular distal radial fractures.A randomized study. J Bone Joint Surg (Am) 2008; 90: 16-22.
8. Kapoor H, Agarwal A, Dhaon B K. Displaced intra-articular fractures of distal radius: a comparative evaluation of results following closed reduction, external fixation and open reduction with internal fixation. Injury 2000;31 : 75-9.
9. Grewal R, Perey B, Wilmink M, Stothers K. A randomized prospective studyon the treatment of intra-articular distal radius fractures: open reduction and internal fixation with dorsal plating versus mini open reduction, percutaneous fixation, and external fixation. J Hand Surg (Am) 2005; 30:764-72.
10. Kreder H J, Hanel D P, Agel J, McKee M, Schemitsch E H, Trumble T E, Stephen D. Indirect reduction and percutaneous fixation versus open reduction and internal fixation for displaced intra-articular fractures of the distal radius: a randomised, controlled trial. J Bone Joint Surg (Br) 2005; 87: 829-36.
11. Anderson J T, Lucas G L, Buhr B R. Complications of treating distal radiusfractures with external fixation: a community experience. Iowa Orthop J2004; 24:
12. Capo J T, Swan K G, Jr., Tan V. External fixation techniques for distal radius fractures.ClinOrthop 2006; 30-41.
13. McQueen M M. Redisplaced unstable fractures of the distal radius. A randomised,prospective study of bridging versus non-bridging external fixation. J Bone Joint Surg (Br) 1998; 80: 665-9.
14. McQueen M M, Hajducka C, Court-Brown C M. Redisplaced unstable fractures of the distal radius: a prospective randomised comparison of methods of treatment. J Bone Joint Surg (Br) 1996; 78: 404-9.
15. Harley B J, Scharfenberger A, Beaupre L A, Jomha N, Weber D W. Augmented external fixation versus percutaneous pinning and casting for unstable fractures of the distal radius--a prospective randomized trial. J Hand Surg (Am)
16. Wright T W, Horodyski M, Smith D W. Functional outcome of unstable distalradius fractures: ORIF with a volar fixed-angle tine plate versus externalfixation. J Hand Surg (Am) 2005; 30: 289-99. Acta
17. Atroshi I, Gummesson C, Andersson B, Dahlgren E, Johansson A. The disabilitiesof the arm, shoulder and hand (DASH) outcome questionnaire: reliability and validity of the Swedish version evaluated in 176 patients. ActaOrthopScand 2000; 71: 613-8.
18. Benson L S, Minihane K P, Stern L D, Eller E, Seshadri R. The outcome of intra-articular distal radius fractures treated with fragment-specific fixation. J Hand Surg (Am) 2006; 31: 1333-9. Brogren E, Petranek M, Atroshi I. Incidence and characteristics of distal radius fractures in a southern Swedish region. BMC MusculoskeletDisord 2007; 8: 48
19. Schnall S B, Kim B J, Abramo A, Kopylov P. Fixation of distal radius fractures using a fragment-specific system. ClinOrthop 2006; 51-7.
20. Musgrave D S, Idler R S. Volar fixation of dorsally displaced distal radius fractures using the 2.4-mm locking compression plates. J Hand Surg (Am) 2005; 30: 743-9.
21. Kopylov P, Runnqvist K, Jonsson K, Aspenberg P. Norian SRS versus external fixation in redisplaced distal radial fractures.A randomized study in 40 patients. Acta Orthop Scand 1999; 70:1-5.