

Comparative study between percutaneous pinning and ligamentotaxis or both for the distal radius fracture

Venkata S. Babu T.¹, Suresh Babu S.^{2*}, Vithal Babu Moturi³

^{1,2}Professor, ³Consultant, ^{1,2}Dept. of Orthopaedics, Dr Pinnamaneni Siddhartha Institute of Medical sciences and research Foundation, Chinnaoutpalli, Andhra Pradesh, ³Chakradhar Hospital, Rajahmundry, Andhra Pradesh

***Corresponding Author:**

Email: drssureshbabu@yahoo.com

Abstract

Introduction: Fractures of the distal radius which are stable i.e., extraarticular and not comminuted are different from fractures which are unstable i.e. intraarticular and comminuted. The final aim in the management of comminuted intraarticular fractures of distal radius is to restore normal function. The best method of obtaining and maintaining an accurate restoration of articular anatomy however remains a topic of considerable controversy.

Methods: In our study 30 cases were treated by ligamentotaxis G1, percutaneous pinning G2 or both G3 were taken into consideration, 10 patients in each group; results were analyzed using Older et al criteria.

Results: The least time of healing was seen in the combination of both group. In ligamentotaxis group 3 cases had excellent results (30%), in percutaneous pinning one case had excellent result (10%) and in the combination group 4 cases had excellent results (40%). In group1, 4 had good results (40%), in group 2, 4 had good results (40%) and in group 3, 4 had good results (40%). In ligamentotaxis group 3 had poor results (30%), in percutaneous pinning group 5 had poor results (50%) and in the combination group 2 had poor results (20%). The percutaneous pinning group showed the poorest results.

Conclusion: In our study combined technique has shown satisfactory result that lead to high rate of return to work, high level of patient satisfaction and low rate of complications. Successful management of complex distal radial fractures necessitates careful assessment of fracture pattern, appropriate patient selection, a careful and meticulous surgical approach, appropriate choice of fixation device and pins, judicious use of Judgment with internal fixation and early rehabilitation.

Keywords: Distal Radius Fracture, Percutaneous Pinning, Ligamentotaxis, Combined Results.

Introduction

Distal radial fractures crush the mechanical foundation of man's most elegant tool, the hand. No other fracture has a greater potential to devastate hand function and no metaphysis of bone is embraced by more precious soft tissues. The same ligaments, retinaculum, tendons and periosteum that envelope the fractures will help to mold the reduction during ligamentotaxis and creates a surgical barrier to open reduction.⁽¹⁾ The term fractures of distal end of radius refer to fractures beginning at the proximal end of pronator quadratus and ending at the radio-carpal articulation. Fractures of the distal radius continue to be one of the most common skeletal injuries treated by orthopaedic or trauma surgeons. These injuries account for approximately one sixth of all fractures seen and treated in emergency rooms. Several of the complications arising were the sequelae of treatment rather than the original fracture. Fractures of the distal radius have been associated with a colour full history since their first description by Pouteau in 1783 and Colles' in 1814. Coone has stated "Fractures of the distal radius which are stable i.e., extraarticular and not comminuted are different from fractures which are unstable i.e., intraarticular and comminuted."⁽²⁾ Therefore different treatment modalities are required for the types of fractures. Number of classification systems have evolved taking into consideration the fracture pattern, degree of comminution, radial

shortening and dorso-palmar displacement, angulation and soft tissue involvement. Several classifications have evolved that recognize some of these variables; however - no classification scheme successfully incorporates all the important attributes of an individual injury. This places the burden on the surgeon to evaluate each fracture individually. The final aim in the management of comminuted intraarticular fractures of distal radius is to restore normal function. The best method of obtaining and maintaining an accurate restoration of articular anatomy however remains a topic of considerable controversy. Recognition of patterns that are inherently unstable and therefore necessitate additional forms of fixation to secure and maintain reduction and prevent late collapse is the key for successful management of the more complex fractures of distal radius. External fixation in combination with percutaneous pinning has proved to be effective in the management of unstable intraarticular fractures of distal radius, but has also linked with an unacceptably high rate of complications in some series.⁽³⁾ The aim of this study is to know the functional outcome of surgical management of comminuted intraarticular fractures of distal end radius and to compare the three different methods of surgical interventions and to prevent finger, elbow and shoulder stiffness by early mobilization.

Materials & Methods

In our study of 30 cases, who were treated by ligamentotaxis, percutaneous pinning or both were taken into consideration, during the study period June 15 to October 15, 2013. All patients with compound fractures, Frykman's III, IV, VII and VIII, comminuted fractures and fractures where reduction was lost following closed reduction and POP application were taken into consideration. Commonest mode of injury was fall on outstretched hand with wrist in dorsiflexion. A careful clinical assessment of skeletal and soft tissue injuries and general condition of the patient was done. The clinical examination gave a clue to determine, whether the fracture was caused by direct or indirect violence. Vascular injuries and peripheral nerve injuries were also carefully looked for. Clinical diagnosis was confirmed by taking anteroposterior and lateral radiographs. All the patients were immobilized in a dorsal/volar POP slab until the time of surgery. Injectable analgesics were given to relieve pain and if the fracture was compound, antibiotics and Tetvac were given. All the surgeries were done under general anaesthesia or brachial Block, with percutaneous placement of pins or K wires. Parenteral antibiotics were given on the day of surgery and oral antibiotics for another week. Every week patient comes for pin dressings.

Follow-up was done for three months from the day of surgery. Active finger, elbow and shoulder exercises are encouraged post-operatively to promote circulation, avoid oedema, stiff fingers, stiff elbow and shoulder. Post-operative check x-ray was taken and a note of radial height, radial angulation and palmar angulation were made. Implants used were Schanz pins (size: 2.5mm-3.5mm), Kirshner wires (size: 2mm-3.5mm), connecting rods and clamps. After reduction, the external fixator was applied with wrist in ulnar deviation and volar flexion for dorsal fractures and dorsiflexion in case of volar fractures, percutaneous pinning for displaced fragments, drop wires for both volar and dorsal Barton fractures. After surgery, the limb was immobilised in cuff and collar sling. Second check x-ray was taken at 6 weeks after surgery. A note of articular congruity, radial height, radial and palmar angulation was made. Fixator was removed between 6-8 weeks interval. No additional splintage was provided after removal; wrist motion was measured by a goniometer following 10 days of exercise with elbow flexed 90 degrees and compared with uninjured side. Results were analyzed using Older et al criteria.

Results

This study consists of 30 cases of comminuted intraarticular fractures of distal radius treated surgically by three surgical modalities. All cases were available for follow up. The average age in males was 31.9 years and female patient age was 50 years. 23 cases were due to fall on outstretched hand, 6 cases were due to road

traffic accidents and one case was due to assault. In this study 23 cases (76.66%) were due to indirect trauma. Fall on outstretched hand was the cause. In 7 cases, direct trauma was the mechanism of injury, which includes road traffic accidents or assault. Frykman's classification was followed 13 (43.33%) fractures were type VIII, 14 (46.66%) were type VII, 2 (6.66%) were type IV and one case (3.33%) was type III. 10 patients (33.33%) had associated fracture. There were 3 cases of fracture ulnar styloid, 2 cases of fracture humerus, 2 cases with fracture shaft ulna, 1 case with fracture calcaneum, 1 case with tendon injury and 1 case with dislocation of elbow. There were 8 cases with pain, persistent or occasional, 2 from ligamentotaxis group (G1) 4 from percutaneous pinning (G2) and 2 cases from combination of both group (G3). Loss of motion at the wrist was noted in 4 cases, 1 case from ligamentotaxis group (G1), and 2 cases in percutaneous pinning and 1 case in combination of both (G3). Infection or pin loosening was seen in 2 cases operated by percutaneous pinning. Reflex sympathetic dystrophy was seen in 1 case operated by ligamentotaxis. Pain and loss of motion at the wrist was seen in 4 cases, 2 cases in ligamentotaxis group (G1), 1 case in percutaneous pinning (G2) and 1 case in the combination of both (G3). 1 case had pain and pin loosening. The difference in the mean time of healing between ligamentotaxis (G1) (6.9 weeks) and percutaneous pinning (6.8 weeks) which is more or less the same and this difference is statistically not significant ($P < 0.620$). Between percutaneous pinning (G2) (6.8 weeks) and the combination of both (G3) (6.7 weeks) the difference in the time of healing is more or less same. The least time of healing was seen in the combination of both (G3) group (Table 1). In ligamentotaxis group (G1), 3 cases had excellent results (30%), in percutaneous pinning (G2), one case had excellent result (10%) and in the combination group (G3) 4 cases had excellent results (40%). In ligamentotaxis group (G1) 4 cases had good results (40%), in percutaneous group (G2) 4 had good results (40%) and in the combination group (G3) 4 had good results (40%). All the three groups were satisfactory. In ligamentotaxis group (G1) 3 had poor results (30%), in percutaneous pinning group (G2) 5 had poor results (50%) and in the combination group (G3) 2 had poor results (20%). The group G2 showed the poorest results (Table 1).

Discussion

30 cases of comminuted fracture of distal end radius that were treated by three different modalities namely ligamentotaxis, percutaneous pinning or a combination of both were followed up for an average of 3 months. The purpose of the study was to evaluate the functional outcome in these patients. These cases were of different age group, occurred in both sexes, and fractures were of different types. The indication for surgery for comminuted fracture distal end radius in our

series were, Failure of closed reduction, Widely displaced fracture with metaphyseal comminution, poly trauma, compound fractures, bilateral injuries. The average age of all the cases in this series was 31.9 years. The fractures were common in the age group 21-30 years of age. The average age in a study of 132 fractures conducted by Jakim I, Pieterse HS, Sweet HB, in 1991, showed that the average of all cases was 35 years.⁽⁴⁾ In a study of 43 fractures in 40 patients conducted by Knirk JL, Jupiter JB; in 1986, showed the average age was 27.6 years.⁽⁵⁾ In a study of 13 patients conducted by Jesse B. Jupiter MD, and Howard Lipton M.D, showed the average age was 35 years.⁽⁶⁾ In a study, conducted by John K Bradway, Peter.C Amadio and William Cooney between 1976 and 1986, the average age was 40 years.⁽⁷⁾ In another study of 40 patients conducted by Zvi Horesh, M.D, Gersten Volpin, M.D, Dory Hoerer M.D, and Haim Stein between 1983 and 1987, the average age was 48 years.⁽⁸⁾ Our study showed that the average age was similar to the reported studies when a smaller group of patients were analyzed. The average age increases when the series consisted of a large group of patients. There were 29 males and only one female patient, showing male preponderance. The sex distribution in a study by I. Jakim, H.S. Pieterse and M.B.E. Sweet, there were 71 men and 44 women.⁽⁴⁾ In a study by Jess. B. Jupiter and Haward Lipton; there were 9 men and 4 women.⁽⁶⁾ In a study conducted by William B. Geissler, et al., there were 38 men and 22 women.⁽⁹⁾ Majority of patients sustained fractured from fall on outstretched hand (76.66%). The other mode of injury was due to road traffic accidents or assault (23.34%). Indirect trauma was the mechanism of injury in 76.66% due to fall on outstretched hand with wrist in dorsiflexion. Direct trauma was the mechanism of injury in 23.34% due to RTA or assault. In our series most of the fractures were Frykman type VII and VIII total constituted 89.99%. In a study conducted by Jessi B. Jupiter and Howard Lipton, six of the thirteen fractures were Frykman type VII and VIII.⁽⁶⁾ In another study by Zvi Horesh et al. of 39 fractures 33 were Frykman type VII and VIII.⁽⁸⁾ In a study conducted by Jupiter JB, Fernandez DL, of 49 fractures there were 44 of Frykman type VII and VIII.⁽¹⁰⁾ The remaining fractures in their series were Frykman type III and IV (9.99%). In the present series 63.34% of the patients were had only comminuted intraarticular distal end radius, while 36.66% had associated injuries. In Jakim series, 81.8% had only comminuted intraarticular fracture distal radius.⁽⁴⁾ In Richard A. Rogachefsky et al., series it was 75.6%, in William P. Cooney et al., series it was 50% and in Steffen J series it was 50.9%.^(9,11) The results are comparable with other series, 36.66% of the patients with associated injuries or associated fractures which needed surgery were operated at the same time. 2 cases had supracondylar fracture humerus which were fixed with K- wires, one patient had fracture metacarpal,

which was fixed with K-wire, and one patient had tendon injury which was repaired. In our series, we had 8 cases with pain, 2 each in ligamentotaxis (G1) and combination of both (G3) and 4 in percutaneous pinning (G2) group. There were 4 cases of loss of motion, 1 each in ligamentotaxis (G1) and combination group (G3) and 2 in percutaneous pinning (G2) group. Infection was seen in 2 patients in percutaneous pinning group (G2). One case of Reflex sympathetic dystrophy was seen in ligamentotaxis group (G1). In our series, percutaneous pinning (G2) was associated with higher complications. The time taken for bone union was 6.9 weeks in G1 group, 6.8 weeks in G2 group and 6.7 weeks in G3 group. P value is <0.620, not significant so, the combination of both group (G3) has taken the least time for bone union. This is probably due to good reduction of the fracture with transfixation of the fracture fragments with Kirschner wires in addition to external fixation particularly helpful in holding articular fragments that had little metaphyseal support. External fixator is applied to provide neutralization of compressive forces acting across the corpus on the small fracture fragments. After restoration of appropriate radial length, volar tilt and angle of inclination, precise articular restoration can be achieved by percutaneously inserting a Kirschner wire and using it as a joy stick to maneuver the articular fragments into position. A Kirschner wire is then inserted at the tip of the radial styloid and anchored to into the ulnar side of the more proximal shaft fragment. Additional percutaneous Kirschner wires are inserted transversely through the radial styloid fragment directly under the subchondral bone to provide subchondral support.

We allowed early mobilization of shoulder, elbow and fingers, which is important for early functional recovery. Outcome is likely improved with shorter duration of external fixation and supplemental K-wire fixation appears to be a favorable adjunct, allowing earlier fixator removal. The comparison of functional result in such a small group is statistically difficult. Small variation in result gives statistically significant numbers. In our series, we have few cases of excellent results mainly due to difficulty in getting good articular congruity, minor degrees of pain and slight limitation of motion. The percentage was 30% in G1, 10% in G2 and 40% in G3. Good results were 40% in all the three groups. In our study, we had 3 cases of poor results in G1 mainly due to persistent pain and slight loss of motion. There were 5 poor results in G2 group. This was mainly due to loss of motion, persistent pain and infection, pin loosening. There were 2 poor cases in G3 group mainly due to occasional pain.

Conclusion

No fracture in the body as ubiquitous and fraught with potential complications as the complex fractures of the distal radius. Recognition of fracture pattern necessitate additional forms of fixation to secure and

maintain reduction and prevent late collapse is the key to successful management of more complex articular fractures of distal radius. Anatomic restoration of these fractures is correlated directly to improved functional result of the affected wrist. In an attempt to stabilize these fractures, a plethora of treatment options exist. People affected were mainly young and active group and most of the fractures were closed. More complications were associated with percutaneous pinning. Fixation of comminuted articular fractures of distal radius with multiple Kirschner wires alone is insufficient to withstand forces across the fracture site and to prevent fracture collapse. However, percutaneous pinning alone can be used if fractures with limited comminution. Ligamentotaxis neutralizes the compressive forces generated across the wrist joint. It provides efficient rigidity until bony healing occurred, thus allowing realignment of severely comminuted fractures. Although the ligamentotaxis can favor and affect the articular surface tilting, severe fracture displacement and significant metaphyseal defects require additional modalities. The use of external fixator in combination with percutaneous

pinning has produced good or excellent results. Intra-operative assessment showed that the external fixator alone was failed to reduce severe articular comminution adequately or to correct and maintain length. Ligamentotaxis supplemented by Kirschner wires has proved to be a reliable means of maintaining an accurate reduction. Duration required for fracture union will be shorter which shall be a favorable adjunct for early fixator removal. In comparative studies, external fixation with percutaneous pinning consistently achieves better anatomical results than done alone. In our study also a combined technique has shown satisfactory result that lead to high rate of return to work, high level of patient satisfaction and low rate of complications. Successful management of complex distal radial fractures necessitates careful assessment of fracture pattern, appropriate patient selection, a careful and meticulous surgical approach, appropriate choice of fixation device and pins, judicious use of Judgmenation with internal fixation, aggressive early rehabilitation and careful post-operative monitoring. The surgeon well oriented with the above principle will be in a position to optimize the outcome of the patients.

Table 1: Mean Duration of Fracture Healing and Results (Older et al (12))

Group	Mean Duration of healing(weeks)	Excellent	Good	Poor
Ligamentotaxis	6.90	3	4	3
Pinning	6.80	1	4	5
Combined	6.70	4	4	2
Total 30	-----	10	10	10

References

1. John. M. Agee, External fixation, Orthopedic clinics of North America, Vol,24,No. 2,1993,265-266,270-274.
2. Cooney WP, Linscheid RL, Dobyns JH: External pins fixation for unstable Colles' fractures: J Bone Joint.
3. Frederik A. Kaempfee and Katherine M. Walker. External fixation for distal radius fractures: Effect of distraction on outcome, Clinical orthopaedics and related research, No. 380, November 2000,220- 225.
4. Jakim I, H.S. Pieterse and Sweet; External fixation of intra-articular fractures of the distal radius, J Bone Joint Surg (Br) 1991, 73-B;302-6.
5. Knirk. J. L, & Jupiter. J.B, Intra-articular fractures of distal radius in young adults, JBJS, 68-A, June 1986, 647.
6. Lipton, The operative treatment of intra-articular fractures of the distal radius, Clinical orthopaedics and related research, No. 292, July 1993, 48-61. Lipton, The operative treatment of intra-articular fractures of the distal radius, Clinical orthopaedics and related research, No. 292, July 1993, 48-61.
7. John K. Bradway, Peter C. Amadio and William P. Cooney, JBJS, Vol. 71-A, 839-847.
8. ZVI Horesh, Ge-rshon Calpin, et al, The surgical treatment of servere comminuted inta-articular fracture of distal radius with the small A.O external fixation device, Clinical Othopedics and related research, No. 263, Feb. 1991,1 47-53.
9. Stephen J. Leibovic and William B. Geissler, Treatment of complex intra-articular distal radium fractures, Orthopedic clinic of North America, Vol. 25, No. 4, October 1994, 685-706.
10. Jupiter JB, Fernandez DL, Toh CL, Fellman T, Ring D. - Operative treatment of volar intra articular fractures of the distal radius, JBJS (Am), 1996 Dec;78 (12):1817-28.
11. William. P. Cooney, Fractures of distal radius, Orthopedic clinics of North America, Vol. 24, No. 2, April 1993, 2013. Jesse B. Jpiter and Howard.
12. Older, T.M, Stabler, E.V. and Cassebaum, W.H. Colle's fracture: Evaluation of selection of therapy. J. Trauma, 5:469-476,1965.