

## A PROSPECTIVE STUDY OF CLINICAL OUTCOME AFTER USING LIGAMENTOTAXIS IN MANAGEMENT OF DISTAL RADIUS FRACTURES

Chandrashekhara V. Mudgal<sup>1</sup>, Madhuchandra R<sup>2</sup>, Manjunath I. Barker<sup>3</sup>

<sup>1</sup>Associate Professor, Department of Orthopaedics, Karnataka Institute of Medical Sciences, Hubli.

<sup>2</sup>Associate Professor, Department of Orthopaedics, Karnataka Institute of Medical Sciences, Hubli.

<sup>3</sup>Postgraduate Student, Department of Orthopaedics, Karnataka Institute of Medical Sciences, Hubli.

### ABSTRACT

#### BACKGROUND

A study was done to evaluate the effect of the ligamentotaxis in the management of intraarticular fractures of the distal radius.

#### MATERIALS AND METHODS

34 patients were studied prospectively between March 2014 and February 2016. All patients had intraarticular fracture of distal end of radius and all were treated with ligamentotaxis after closed reduction with fluoroscopic guidance. The follow-up period was 12 months. At the time of surgery, the mean age was 45.29 years.

#### RESULTS

In all fracture cases, the mean of fracture union was 5.8 weeks. During the final follow-up, the mean range of motion was 55.30 in flexion, 56.60 in extension, 21.0 in ulnar deviation, 9.00 in radial deviation, 70.30 in pronation and 67.10 in supination. According to the scoring system of Gartland and Werley, the clinical and functional outcomes showed that 15 patients (44.1%) had excellent results, 14 (41.1%) had good results, 3 (8.8%) had fair results and 2 (5.8%) had poor results.

#### CONCLUSION

Closed reduction under fluoroscopic image guidance and the ligamentotaxis is useful and effective in the treatment of intraarticular fractures of the distal radius.

#### KEYWORDS

Ligamentotaxis, Articular Fracture, Distal Radius, K-Wire, Fluoroscopic Guidance.

**HOW TO CITE THIS ARTICLE:** Mudgal CV, Madhuchandra R, Barker MI. A prospective study of clinical outcome after using ligamentotaxis in management of distal radius fractures. *J. Evid. Based Med. Healthc.* 2017; 4(31), 1831-1835. DOI: 10.18410/jebmh/2017/357

#### BACKGROUND

Distal end radius fractures are very commonly encountered by orthopaedicians. Middle-aged and elderly women are most commonly affected. In young men, distal end radius fractures are caused due to high velocity trauma. In adults fracture of distal end radius forms 15% of overall fractures.<sup>1</sup> Right side distal radius fractures are more common than left. Distal radius fractures affect the mechanical strength and skill of one man's functional tool, the hand. Failure in treatment may cause permanent functional disability.<sup>2</sup> The distal radius fractures constitute about 75% of all type of forearm fractures as noted by WP Cooney et al<sup>3</sup> in their study. If the fracture is severely comminuted or has intra-articular involvement, treatment becomes more challenging to even an expert and experienced orthopaedic surgeon.

Various surgical interventions are available presently like percutaneous pinning, intrafocal pinning, external fixator and plate fixation.<sup>4</sup> Bridging external fixation forms the heart of ligamentotaxis as it allows distraction at the radiocarpal joint.<sup>5</sup> The moulding of fracture fragments into alignment by traction force applied across the fracture through the surrounding soft tissue is known as ligamentotaxis. Anderson and O'Neil were first to maintain fracture reduction with an external fixator using the principle of ligamentotaxis. The term ligamentotaxis stresses on the traction and the counter traction by ligaments and soft tissue surrounding the bone and it will restore the length and reduction of the fracture fragments, which otherwise very difficult to control.<sup>6</sup> This ligament and soft tissue tension can be maintained in position by external fixator or by a distractor.

The most important and demanding part of operative fracture treatment is the reduction and proper alignment of the fragments, which must be gentle to the surrounding soft parts and to the bone to preserve the essential blood supply to all tissues.<sup>7</sup> The present consecutive prospective study comprises of 34 cases of comminuted intra/juxta articular fractures admitted in our institution managed by the principle of ligamentotaxis one must bear in mind some important anatomical landmarks when planning for ligamentotaxis for the distal radius fractures. The articular

*Financial or Other, Competing Interest: None.*  
*Submission 22-02-2017, Peer Review 30-02-2017,*  
*Acceptance 12-04-2017, Published 15-04-2017.*  
 Corresponding Author:  
 Dr. Chandrashekhara V. Mudgal,  
 Associate Professor, Department of Orthopaedics,  
 Karnataka Institute of Medical Sciences, Hubli.  
 E-mail: drmudgal@yahoo.com  
 DOI: 10.18410/jebmh/2017/357



surface of the radius is triangular. The apex of this triangle points to the radial styloid. The radius articular surface slopes in an ulnar and volar direction with a radial length of 12 mm (range 8-18 mm) and an average volar tilt of 12° (1-21°) and a radial inclination of 23° (range 13-30°).<sup>8</sup> The dorsal surface is irregular, convex and is thin, which often results in comminution that can lead to a dorsal tilt.

The volar ulnar lip of the distal radius has the highest density even in the osteopenic bone.<sup>9</sup> Hence, the ulnar volar lip of distal radius is chosen for putting dorsal pins in ligamentotaxis.<sup>9</sup>

The dorsum of the radius is covered by the arborisations of the Superficial Radial Nerve (SRN) and the dorsal cutaneous branch of the ulnar nerve. The SRN exits under brachioradialis, approximately 5 cm proximal to the radial styloid and divides into a volar and a dorsal branch at an average distance of 4 cm proximal to the radial styloid. Partial or complete overlapping of the lateral antebrachial cutaneous nerve with the superficial radial nerve occurs in up to 75% of the time.<sup>10</sup>

The dorsal cutaneous branch of the ulnar nerve, which arises from the ulnar nerve at a landmark 6 cm proximal to the ulnar head and it is subcutaneous 5 cm proximal to the pisiform. It also crosses the ulnar snuffbox and gives 3 to 6 branches that supply the ulnar and dorsal aspect of the carpus, small finger and ulnar ring finger. Pin insertion with open method allows identification and protection of these branches. The proximal pins of ligamentotaxis are placed at the junction of the proximal and middle thirds of the radius. The radius is covered by the tendons of extensor carpi radialis brevis and extensor carpi radialis longus and also the extensor digitorum communis. While inserting the proximal pins in mid-lateral position, the brachioradialis tendon and the SRN to be retracted. Proximal pins can also be inserted in dorsolateral position between the extensor carpi radialis longus and extensor carpi radialis brevis. In order to decrease the risk of SRN injury, proximal pins can be inserted in dorsoradial position between the extensor carpi radialis longus and extensor carpi radialis brevis or dorsally between the extensor digitorum communis and extensor carpi radialis brevis.<sup>11</sup>

**MATERIALS AND METHODS**

A prospective study was conducted at Department of Orthopaedics, Karnataka Institute of Medical Sciences, Hubli, between March 2014 to February 2016. All patients above the age of 18 years with intraarticular fracture of distal end of radius who were medically fit and who gave consent were included in this study. The patients with pathological fracture, fracture more than 2 weeks old, nonunion, fracture with neurovascular complications, fracture associated with other bone fracture in the wrist hand or forearm and complex fractures with depression of articular surface and fracture radial styloid were excluded from study. After taking written informed consent, 34 patients were included. Surgery was performed and consisted of closed reduction under image intensifier followed by 5 mm incision for 4 Schanz pins, 2 in the middle

third of the radius on the dorsolateral aspect about 10-12 cm from distal end of radius and 2-3 cm apart. Care taken to avoid injury to radial nerve. The fracture fragments were made into a more normal alignment and gentle flexion and ulnar deviation was maintained. The reduction was confirmed through image intensifier and then external fixation device was locked into place using bars and clamps. The small external fixator was removed after 6 weeks. K-wire was used depending on the severity of intraarticular comminution. Patients were started on physiotherapy soon after the surgery. Patients were followed up to 3 weeks after surgery and thereafter every month till one year. Functional outcome was evaluated using a modification of scoring system used by Gartland and Werley<sup>12</sup> (Table 2). With a goniometer dorsal and volar flexion, radius and ulnar deviation, pronation and supination was calculated and compared with unaffected wrist.

**RESULTS AND OBSERVATIONS**

AO TYPE	Number of Cases
A2	7
A3	14
B2	2
B3	4
C2	5
C3	2

**Table 1. AO Classification of Cases**

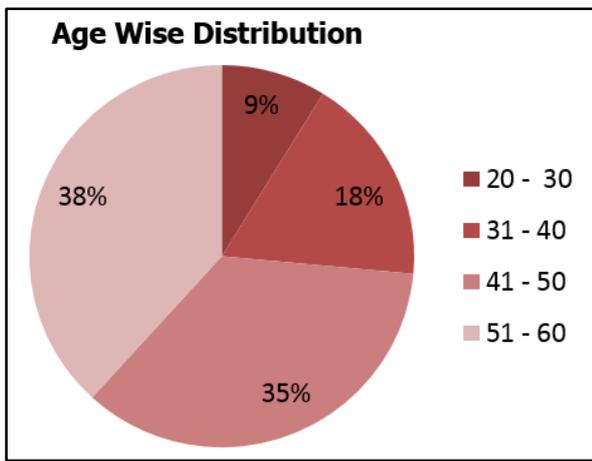
Residual deformity	Range 0-3 points
Prominent ulnar styloid	1
Residual dorsal tilt	2
Radial deviation of hand	2-3
Subjective evaluation	Range 0-6 points
Excellent - No pain, disability or limitation of movements	0
Good - Occasional pain, limitation of motion, no disability	2
Fair- Occasional pain, some limitation of motion, weakness in wrist, no disability if careful, activities slightly restricted	4
Poor - Pain, limitation of motion, disability, activities more or less markedly restricted	6
Objective evaluation	Range 0-5 points
Loss of dorsiflexion	5
Loss of ulnar deviation	3
Loss of supination	2
Loss of palmar flexion	1
Loss of radial deviation	1
Loss of circumduction	1
Pain in DRUJ	1
Grip strength 60% or less than opposite side	1

DRUJ=Distal radioulnar joint

**Table 2a. Gartland and Werley Scoring System**

0-2	Excellent
3-8	Good
9-20	Fair
>20	Poor

**Table 2b. Gartland and Werley Scoring System**



**Figure 1. Age Distribution of Cases**



**Figure 4. Follow Up X-Ray 6 Weeks**



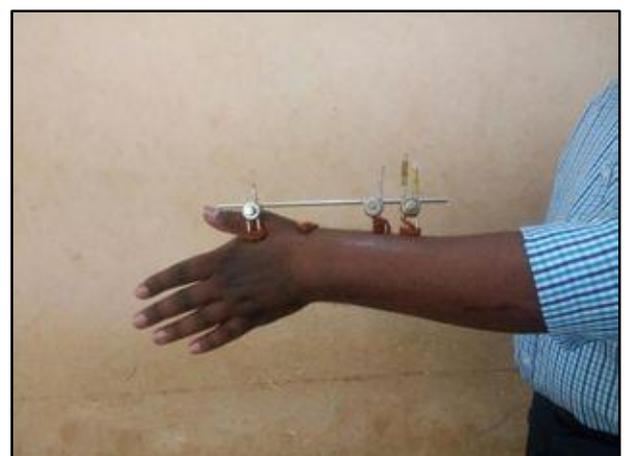
**Figure 2. Preop X-Ray showing Intra-Articular Fracture of Distal End of Radius**



**Figure 5. Clinical Photograph showing Ligamentotaxis with Pin Tract Dressing K-Wires have been put for Augmentation**



**Figure 3. Postop X-Ray, External Fixator along with K-Wires in Situ**



**Figure 6. Clinical Photograph showing Ligamentotaxis with Pin Tract Dressing**



**Figure 7. Dorsiflexion in a Patient at Follow Up**



**Figure 8. Palmar Flexion in Same Patient at Follow up Period**



**Figure 9. Supination to Full Range**



**Figure 10. Pronation**

In our study, 34 patients with the age group of 20-60 years with mean age 45.29 years were studied. 20 were males and 14 were female patients. The most common mode of injury was fall on an outstretched hand, right side was more commonly (55.88%) involved and majority of cases were of closed type (94.11%). A3 type was 41% according to AO classification (Table 1). In age distribution of cases, fracture was more common in 51-60 age group followed by 41-50 and 31-40 and least common in 21-30 age group. Clinical and radiologic evaluation was performed on the first and seventh days at 6 weeks and 2 years after surgery. The overall clinical and functional outcome was formulated using Gartland and Werley scoring system<sup>6</sup> (Table 2). The mean range of motion was 53.8° in flexion, 55.6° in extension, 10° in radial deviation, 21.8° in ulnar deviation, 68° in supination and 71° in pronation. Final results were excellent in 15 patients (44.11%), good in 14 patients (41.11%), fair in 3 patients (8.8%) and poor in 2 patients (5.8%) (Table 1 and 2). There were no instances of extensor tendinitis or pin loosening in the distal fragment; however, there were 4 cases of proximal pin track infections.

#### DISCUSSION

Treatment of fracture of distal end of radius is a challenge for orthopaedic surgeon starting from the reduction of fracture to maintenance of reduction till the fracture is united and mobility of the joint occurs after complete fracture union. Permanent disability can occur in case of treatment failure.<sup>13</sup> A good functional result usually accompanies a good anatomical reduction.<sup>14</sup> Bridging external fixator with ligamentotaxis for treatment of fracture distal end of radius has given promising results.<sup>15</sup> The good result of ligamentotaxis in neutralising compression forces, which cause displacement of unstable fracture with radial shortening is an increasingly appealing advance in the management of distal radius fracture.<sup>6</sup> In our study, we treated 30 cases of fracture. There were 20 (58.8%) males and 14 (41.2%) female patients. In our study, 51-60 age group was affected the most probably indicate the risk factors in aged like osteoporosis, malnourishment, etc. In our study, there were 2 diabetic patients and 2 hypertensive patients, all disease under well control. Fracture healing was not affected by these diseases and fracture healed within 6 to 8 weeks. We restricted our study the functional outcome in our study was 44.11% excellent, 41.11% good, 8.8% fair and 5.8% poor, whereas according to Jenkins et al,<sup>16</sup> it was 40.6% excellent, 53% good, 3% fair and 3% poor. According to study by Maruthi C V and Shivanna done in Karnataka,<sup>17</sup> the results were 30.2% excellent, 46.66% good, 16.6% fair and 6.6% poor. After comparison, we noticed that our study had excellent and good result in 85.2% of all cases. In Maruthi et al study,<sup>17</sup> there were 5 cases of malunion, but in our study, there were 4 cases of malunion. In their study, 2 were dorsal tilt and 3 with lateral tilt, but with minimal restriction of movements and functional disability. In our study, all 4 cases were dorsal tilt. Out of 5 cases, there were 2 cases of comminution. In our study, 3 patients developed wrist stiffness probably due to 7 weeks

of wrist immobilisation and 3 patients developed feature of RSD (reflex sympathetic dystrophy) because of discontinuation of physiotherapy. One developed reduced range of pronation and supination, because of involvement of distal radioulnar joint. In all the 4 cases who developed malunion in our study, there was reduced handgrip strength. We did not come across any case of nonunion and neurological deficit.

### CONCLUSION

From our study, we conclude that closed reduction under image intensifier and ligamentotaxis is very effective in the management of intraarticular fracture of distal radius. Fracture of distal end of radius is more common in age group between 51-60 yrs. and more common in males and more commonly seen because of fall on outstretched hand. Right side was affected more than the left side. Result was excellent and good in 85.2% patients. Hence, we conclude that ligamentotaxis is good method for treatment of distal radius fractures.

### ACKNOWLEDGEMENTS

Authors would like to thanks to all the faculty and postgraduates of Department of Orthopaedics, KIMS, Hubli, and also like to express gratitude to study subjects.

### REFERENCES

- [1] Mehboob I, Anjum MP. Fixation of extra articular distal radius fractures with non-bridging external fixator. *Nepal Med Coll J* 2008;10(2):115-117.
- [2] Wadsworth TG. Colles fracture: failure in management may cause permanent disability. *British Medical Journal* 1990;301:192-194.
- [3] Alffram PA, Bauer GC. Epidemiology of fractures of the forearm. A biomechanical investigation of bone strength. *J Bone Joint Surg Am* 1962;44A:105-114.
- [4] Canale TS. *Campbell's operative orthopaedics*. 10<sup>th</sup> edn. Vol. 3. St. Louis: Mosby 2003:3058-3069.
- [5] Boholz RW, Hackman JD. *Rockwood and Greens fracture in adults*. 5<sup>th</sup> edn. Vol. 1. Lippincott Williams and Wilkins, Wolter Kluwer Company 2001:829-880.
- [6] Connolly JF. Non-operative fracture treatment. In: Bucholz RW, Heckman JD, eds. *Rockwood & Green's fractures in adults*. 5<sup>th</sup> edn. Vol. 1. Philadelphia: Lippincott Williams & Wilkins 2001:p. 142.
- [7] Ruedi TP, Sommer C, Leutenegger A. New techniques in indirect reduction of long bone fractures. *Clin Orthop* 1998;347(2):27-34.
- [8] Feipel V, Rinnen D, Rooze M. Postero-anterior radiography of the wrist. Normal database of carpal measurements. *Surg Radiol Anat* 1998;20(3):221-226.
- [9] Gausepohl T, Worner S, Pennig D, et al. Extra-articular external fixation in distal radius fractures pin placement in osteoporotic bone. *Injury* 2001;32(suppl 4):79-85.
- [10] Mackinnon SE, Dellon AL. The overlap pattern of the lateral antebrachial cutaneous nerve and the superficial branch of the radial nerve. *J Hand Surg* 1985;10(4):522-526.
- [11] Emami A, Mjoberg B. A safer pin position for external fixation of distal radial fractures. *Injury* 2000;31(9):749-750.
- [12] Gartland JJ, Werley CW. Evaluation of healed Colles' fractures. *J Bone Joint Surg Am* 1951;33(4):895-907.
- [13] Boparai RPS, Boparai RS, Kapilar R, et al. Role of ligamentotaxis in management of comminuted intra/juxta articular fractures. *IJO* 2006;40(3):185-187.
- [14] Green DP. Pins and plaster treatment of comminuted fracture of the distal end of the radius. *JBJS* 1975;57(3):304-310.
- [15] Cooney WP, Linscheid RL. External pin fixation for unstable Colle's fracture. *JBJS* 1979;61(6):840-845.
- [16] Jenkins NH, Jones DG, Johnson SR, et al. External fixation of Colles fracture: an anatomical study. *JBJS* 1987;69(2):207-211.
- [17] Maruthi CV, Shivanna. Management of fracture of distal radius by external fixator using the principle of ligamentotaxis a prospective study. *Indian Journal of Orthopaedics Surgery* 2015;2(1):19-26.