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Original Article

Comparison of treatment of unstable intra articular fractures of distal radius with locking plate versus non-locking plate fixation

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ABSTRACT

Introduction: Unstable intra articular fractures of distal radius are frequently being managed with open reduction and internal fixation. Of late in some biomechanical studies locking plates have been shown to be better in terms of maintenance of radiological parameters in comparison to non-locking plates. We conducted this study to know whether this biomechanical superiority of locking plates is converted in to better clinical outcomes.

Materials and methods: A study was conducted in 60 patients (30 in each group) with unstable intra articular fractures of distal radius who were treated by open reduction and internal fixation with locking plates and non-locking plates. Patients were evaluated for radiological parameters (intra articular step off, radial height, radial tilt, volar tilt) and functional parameters (flexion, extension, radial deviation, ulnar deviation, pronation, supination grip strength) at two year follow up. Overall outcome was evaluated by scoring systems of Gartland and Werley and modified Green O' Brien.

Results: The change in radiological parameters from immediate post op to latest at two year in locking plate group was not significant for radial height, radial tilt, volar tilt, but ulnar variance whereas in non-locking plate there was significant change in radial height, volar tilt, ulnar variance but no significant change in radial inclination. In clinical and functional outcome no significant difference was found at two year follow up.

Conclusions: Locking plates maintain the radiological parameters better than non-locking plates but functional outcome are same for both plates at two year after surgery.

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1. Introduction

Fractures of distal end of radius are common.¹ They occur in elderly as a result of weakened osteoporotic bones but in

young they are due to high energy trauma leading to intra articular involvement. Knirk and Jupiter² reported a 65% prevalence of post-traumatic arthrosis after intra-articular fracture of distal end of radius in forty three young adults

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and demonstrated a strong correlation between residual articular incongruity and osteoarthritis. It is also known that extra articular malalignment can lead to decreased grip strength and endurance⁴ as well as limited motion and carpal instability.^{5–8} In high demand young adults to avoid post-traumatic joint arthrosis intra-articular fractures should be anatomically reduced. To achieve anatomical reduction methods of treatment involving open reduction and internal fixation with volar plates are being preferred. Conventional non-locking have been reported to give effective treatment for displaced unstable intra-articular fracture of distal radius.³ Volar locked plating has gained vast popularity for treatment of both extra and intra articular fractures of distal radius due to its favourable functional and radiological outcome.^{9–11} However currently we are unaware of the studies that have focused on comparison of radiological and functional outcome between non-locking and locked plates.

On the basis of biomechanical studies of two types of plating systems it could be predicted that locking plate will have a better outcome in comparison to non-locking.¹² But no reliable clinical data is available to prove or disprove this prediction.¹²

We have conducted this study with the hypothesis that locked plates are better than non-locking plates in maintaining radiographic parameters and functional outcome in intra articular fractures of distal radius.

1.1. Subjects and methods

This study was conducted at a tertiary level orthopaedic surgery centre. All patients of age group 18–65 years with intra-articular fractures of distal end radius were close reduced and casted. All patients who did not achieve acceptable reduction or lost reduction at first follow up visit within one week were advised ORIF and those willing were included in study after taking written consent. Criteria used to determine unacceptable reduction were radial height shortening of >5 mm, radial inclination on postero-anterior film <15°, intra-articular step off >2 mm, dorsal tilt >15° and volar tilt >20°. Patients having open fractures, concomitant upper extremity injury, patients with bilateral wrist fractures, those who were managed surgically more than two weeks after injury and patient with multi-organ or head injury, were excluded from study. All patients were operated within 2 weeks of injury. AO/ASIF classification was used to classify fractures. Consecutive patients were alternately allocated to locking plate group and non-locking plate group. Total 60 patients (30 in each group) were included in study between November 2008 and June 2011. Fracture pattern distribution in locking plate group was B2:2; B3:5; C1:1; C2:6; C3:16 while in non-locking plate group it was B2:3; B3:7; C1:1; C2:5; C3:14. Mean age was 36.1 years. 75% patients were in age group 25–45 years. Females constituted 11.67% of whole study. Overall 66% patients had their dominant extremity involved in this series. Mechanism of injury included bike riding (44 cases) fall (9 cases) sports (5 cases) automobile accident (2 cases) (Figs. 1–3).

1.2. Surgical technique

All operative procedures were performed by same team. Standard volar approach of Henry¹³ was used. Linear incision

Fig. 1 – a. Volar approach of Henry to distal radius fractures.

lateral to flexor carpi radialis were given by retracting brachioradialis and radial artery laterally and flexor carpi radialis along with median nerve medially. Pronator quadrates was exposed and incised at its radial insertion. Fracture site exposed after retracting pronator quadrates ulnarly.

Articular surface was assessed with c arm, plates were kept on volar side and sliding hole was fixed first and plate was readjusted with respect to articular surface. Distal screws were placed in subchondral bone. No bone grafting was done in any fracture. K wires were used to secure small fragments.

1.3. Follow up examinations

Patients were kept in below elbow slab for one week. Followed by removable volar splint for 3 weeks. Immediate post op X-rays were done. At latest followup patients were evaluated with X-rays, clinical parameters and overall scoring systems of Gartland and Werley¹⁴ and modified Green O' Brien score¹⁵ Immediate postoperative radiographs were compared to those at final follow up (at twenty four months). An observer who performed all radiographic measurements was blinded to the clinical history and outcome. Range of motion of wrist and grip strength was evaluated by same external observer who made radiographic measurements. Grip strength was measured with Jamar dynamometer and compared with that of contralateral hand.

All patients were evaluated with scoring systems of Gartland and Werley¹⁴ as well as Green O' Brien.¹⁵ Scoring system of Gartland and Werley emphasizes upon clinical and radiographic data whereas Green O' Brien depends upon subjective and objective clinical data.

Results: Out of total 60 patients enrolled for study only 52 completed the follow up at two years. Three from locking plate group and five from non-locking plate group lost follow up.

1.4. Clinical results

The mean of range of motion and grip strength at final follow up (at twenty four months) for two groups are given in Table 1. There was no statistical difference between two groups for active range of motion and grip strength.

Fig. 2 – a. Locked plating of distal radius AP view – immediate post op X-ray. b. Locked plating of distal radius lateral view – immediate post op X-ray. c. Same patient of locked plating of distal radius AP view – at two years follow up. d. Same patient of locked plating of distal radius lateral view – at two years follow up.

1.5. Radiological results

Radial inclination: There was no significant difference in radial inclination achieved in immediate post op (p value = 0.43) in both groups. At the end of twenty four months also, there was no significant difference in radial inclination in both groups (p value = 0.88). There was no significant change in radial inclination from immediate post op. to latest follow up in locking plate group (p value = 0.14) as well as in non-locking plate group (p value = 0.85).

Radial height: No significant difference between means of radial heights of two groups in immediate post op (p value = 0.54). At the end of twenty four month follow up again there was no significant difference (p value = 0.20). Also there was no significant change in means from immediate post op to latest follow up at twenty four months in locking plate group (p value = 0.82). However there was significant decrease in radial height from immediate post op. to latest follow up (p value = 0.050) in non-locking plate group.

Volar tilt: In immediate post op. mean volar tilt was 6.63° in locking plate group whereas in non-locking plate group it was 8.23° . There was no statistical difference in these (p value = 0.43). At latest follow up it was 7.1° in locking plate group and 7.4° in non-locking plate group. Again there was no statistically significant difference (p value = 0.74). There was no significant change in volar tilt from immediate post op to latest follow up at twenty four months in locking plate group (p value 0.49) but a significant change in volar tilt was seen in non-locking plate group over time (p values = 0.04).

Ulnar variance: In immediate post op. locking plate group had mean ulnar variance of -0.16 mm whereas in non-locking plate group it was -0.33 mm (p value = 0.40). At latest follow up ulnar variance in locking plate group was 0.1 mm whereas in non-locking plate group it was 0.06 mm (p value = 0.61). These were statistically insignificant. There was significant change in ulnar variance in both groups from immediate post op. to latest follow up (p values = 0.04, 0.02 respectively).

Fig. 3 – a. Non-locking plating of distal radius AP view – immediate post op X-rays. b. Non-locking plating of distal radius lateral view – immediate post op X-rays. c. Same patient's X-rays AP view at two year follow up. d. Same patient's X-rays lateral view at two year follow up.

Table 1 – Comparison of Clinical Outcomes.

	Locking plate	Non-locking plate
Flexion	75.2	71.6
Extension	77.2	74.5
Pronation	67.5	66.7
Supination	89.6	87.6
Radial deviation	80.3	77.3
Ulnar deviation	76.9	76.0
Grip strength	73.1	73.3

Outcomes in terms of Gartland and Werley as well as Green O' Brien score are given in Table 2.

Final scores were not significantly different in two groups.

Most common complication was k wire infection (total 7 cases, 2 in locking plate group and 5 in non-locking plate group). Superficial infection was second most common complication (1 in locking plate group and 3 in non-locking plate group). Other complications included median neuropathy (one case in each group) pain over plate (2 cases only in locking plate group), shoulder hand syndrome (one case in locking plate group), reflex sympathetic dystrophy (one case in each group) and tourniquet palsy (one case in locking plate group).

2. Discussion

Even though fractures of distal radius are among the most common fractures treated by orthopaedic trauma and hand surgeons, treatment options are variable and remain a topic of debate.¹⁶ Factors such as fracture pattern, associated injuries, general health of the patient, bone quality and patients functional demand should be considered when choosing the treatment. For intra articular fractures Trumble et al¹⁶ stated that degree to which articular step off, gapping between fragments and radial shortening can be improved with surgery strongly correlates with improved outcome. Hence treatment method which is more likely to achieve these goals will result in better function.

We have found that there was no significant difference between locking plate and non-locking plate in terms of clinical outcome. However radiological parameters were better maintained by locking plates over the period of two years. We could not find any prospective study comparing locking plates with non-locking plates in management of unstable intra-articular distal radius fractures in English literature. However there are some studies^{3,11,17–19} which have

evaluated the results of operative treatment of distal radius fractures using either locking plates or non-locking plates. In a prospective study with locking plates Kevin C Chung et al.¹⁰ have demonstrated that at end of one year follow up, operated wrist had flexion 86.1%, extension 95.4%, ulnar deviation 82.7%, radial deviation 98.4%, pronation 97.8%, supination 114.8% of contralateral side. Egol et al¹⁶ have reported that with use of volar locking plates for unstable intra-articular distal radius fractures the operated side had flexion 82%, extension 87%, radial deviation 96%, ulnar deviation 78%, pronation 100%, supination 95% of contralateral side at one year follow up. While in our study flexion was 80%, extension 82%, radial deviation 92%, ulnar deviation 81%, pronation 72% and supination 89% of contralateral side at two years.

In non-locking plate group (in our study) flexion was 76%, extension was 79%, radial deviation 82%, ulnar deviation 81%, pronation 71%, supination 92% grip strength 78% (percentage of contralateral side). Fitoussi et al² have reported mean recovery of 52 degrees of dorsiflexion, 52 degrees of palmar flexion, 88° of pronation, 14 degrees of radial deviation, and 26 degrees of ulnar deviation at two years follow up. Jupiter JB et al¹⁷ have shown average active pronation 72° and active supination 78° as compared with 71 and 82° respectively for contralateral forearm. Active extension of the involved wrist averaged 58° and active flexion averaged 66° compared to 64 and 75° respectively for contralateral side. Active radial deviation of involved wrist averaged 22° and active ulnar deviation averaged 42° as compared to 23 and 46° respectively for contralateral forearm. However mean follow up in their study was 51 months as compared to twenty four months in our study. However Kreder et al¹⁸ have shown that functional score are stable after one year and that additional follow up after one year is not indicated. Meanwhile Frankie Leung et al²⁰ have contended that results keep on improving up to 24 months after surgery.

No complications were specific to any study group. Pain over plate was exclusively seen in locking plate group (only 2 cases) but their significance is unknown. Overall complication rate in our study was 31%. However most complications were mild and did not affect over all prognosis of patients.

Our study has several limitations. We have used X-rays to evaluate radiological parameters. While taking these X-rays dead postero-anterior and lateral views might not have been taken leading erroneous recording of radiological parameters. Secondly measuring one or two degrees of radiological parameters on radiograms is difficult which could lead to altered results of study. CT scan would have been a better option to evaluate radiological parameters. We could not use it because of resource limitation. Many patients failed to afford the cost of implant and hence opted out of the study. These patients belonged to low socio economic strata (manual labourers) who indulge in heavy work in whom results could have been different from those whose profession involves table work. Follow up in our study is of twenty four months which is not enough to evaluate late complication such as osteoarthritis, tendon rupture etc.

Additional fixation with k wires was also used to hold the fragments which could not be fixed with plate and screws. So results obtained might have been altered by these in both groups.

Table 2 – Comparison of overall outcomes in terms of Green O' Brien score and Gartland and Werley scores.

	Green O' Brien score		Gartland and Werley score	
	Locking plate group	Non-locking plate group	Locking plate group	Non-locking plate group
Excellent	70%	56%	56%	54%
Good	11%	24%	41%	36%
Fair	15%	20%	3%	8%
Poor	4%	0%	0%	0%

In this study we conclude that locking plates are better comparison to non-locking plates in maintaining radiological parameters in intra articular distal radius fractures however no significant difference in clinical or subjective outcome. Both of them seem to be an effective method of treatment.

Conflicts of interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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