

Functional Outcome of Volar Locking Plates in Fractures of Distal End Radius in Osteoporotic Individuals

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ABSTRACT

Introduction: Longer life expectancy and more active lifestyles have increased the incidence of distal radius fractures in the older population. Osteoporosis primarily weakens metaphyseal bone by decreasing trabecular volume. Even low energy trauma in osteoporotic bone leads to comminuted fractures. Achieving reliable fixation in osteoporotic fractures is a challenge. We evaluated use of volar locking plates in treatment of these common fractures in elderly.

Material and methods: 87 patients with singh's index 3,2 or 1 with closed unstable distal end radius fractures according to lafontain criteria were followed over period of 24 weeks post op. objective parameters like maintainance of reduction evaluated by serial radiographs, range of motion of wrist, grip strength were recorded as well as subjective parameters like patient satisfaction by functional score called as patient rated wrist function.

Results: range of motion of wrist, grip strength as well as functional score showed gradual improvement over period of 24 weeks. Serial radiographs showed maintainance of intraop reduction during follow up.

Conclusion: volar locking plates appears to provide good functional outcomes in fracture distal end radius in osteoporotic individuals. Long term studies with large sample size are required to confirm these findings.

Keywords: Volar Locking Plates, Fractures of Distal End, Radius in Osteoporotic

INTRODUCTION

Longer life expectancy and more active lifestyles have increased the incidence of distal radius fractures in the older population. Osteoporosis, the skeletal hallmark of advanced age, is a ubiquitous condition that primarily weakens metaphyseal bone by decreasing trabecular volume. This entity is a widely recognized risk factor for patients to sustain fractures with lower-energy trauma and also changes the character of the fracture. Compression failure of the metaphysis produces a defect or void, which increases fracture instability.¹ Great emphasis has been given to the surgical management of hip fractures in this age group because these can be life-threatening injuries. On the other hand, distal radius fractures, not having the same grave consequences, have been managed less aggressively and little thought has been given to the duration, discomfort, and disruption of lifestyle incurred during treatment. An upper extremity that remains dysfunctional for a prolonged period produces a severe coping problem for the elderly. Closed reduction and casting can produce satisfactory results in patients of low functional demands; however, this does

not maintain correction in unstable fractures, and casts prove heavy and cumbersome. Pinning is frequently ineffective for osteoporotic bone. Conventional volar nonlocking plates leads to poor distal screw purchase and subsequent loosening & backout of screws. Dorsal plate fixation is associated with soft tissue problems, and external fixation carries the risk of pin tract infections and stiffness of the wrist.²

The locking screws in the volar locking plate system offer advantage over previous implants. With previous volar plate designs involving nonlocking screws, screw purchase in the metaphysis of the distal part of the radius often was poor because of the limited amount of cortical bone in this location. With locking design, the distal screws are locked to the plate, which stabilizes the screws against lateral movement (toggle) and resists loosening. This provides additional strength to the fixation by constructing a scaffold under the distal radial articular surface. The proximal diaphyseal screws fix the plate strongly to thick cortical bone, completing this stable form of fixation. Subchondral support pegs do not induce interfragmentary compression but firmly maintain bony alignment. In this study we tried to evaluate efficiency of volar locking plates for managing this challenging fracture.

Study aimed to analyze the efficacy of volar locking plates in distal end radius fractures occurring in osteoporotic individuals to achieve a high degree of functional results. With objectives to establish outcome of volar locking plates for fracture distal end radius in osteoporotic individuals in form of

- Range of motion of wrist joint.
- Hand grip power.
- Maintenance of reduction

And to identify influence of various factors on functional outcomes

- Age
- Sex

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- Mode of trauma
- Type of fracture
- Interval between injury and operation
- Degree of osteoporosis
- Radiological parameters

MATERIAL AND METHODS

This was a prospective study. All patients more than 60 years of age with grade 3, grade 2 or grade 1 singh's index³ with closed unstable distal radius fractures were included in this study. Fractures were categorized according to the AO classification system. We identified unstable distal end radius fracture as per Lafontaine criteria.⁴ This criteria considers five factors which indicate instability. (1) Initial dorsal angulation greater than 20 degrees, (2) dorsal comminution, (3) radiocarpal intra-articular involvement, (4) associated ulna fractures, and (5) age greater than 60 years. Fractures presenting with three or more of these factors are considered as unstable. We excluded patients with Open fracture, poor general condition, hemodynamically unstable, bilateral wrist fracture, Concomitant ipsilateral upper limb fracture and Old healed wrist fracture on opposite side. Within a week after the application of the volar locking plating system, all patients started wrist ROM. Patients were allowed to perform activities of daily living one week after the surgical procedure while wearing the splint. Strengthening exercises were started 2 wks post surgery

Patients underwent outcomes assessments at six, twelve and twenty four weeks after the surgical procedure. At each visit, standard posteroanterior and lateral projection radiographs were taken. The degree of fracture displacement was assessed with measurement of radial tilt angle, radial shortening, and articular incongruity on posteroanterior view and radial inclination angle on lateral view.

We measured hand function by both objective and subjective measures. Objective hand function measurement included tests of grip strength, wrist and forearm range of motion (flexion, extension, radial deviation, ulnar deviation, pronation, and supination). Grip strength was measured using Dynamometer. Grip strength of affected side was expressed as percentage of normal side.

The subjective measurement of hand function was patient rated wrist evaluation.⁵ It evaluates parameters like pain, usual daily activities like washing and specific activities like turning door knob by affected hand. The patient rated wrist evaluation was self-administered by the patient at each visit. At each follow-up visit, the patient was examined for Postoperative complications, including infection, neuropathy, tendon injury, nonunion, chronic regional pain syndrome, plate loosening, plate-site discomfort or refracture. Patients requiring additional intervention were identified, and their treatments were recorded

RESULTS

94 patients operated in our institute by open reduction and internal fixation with use of the volar locking plating system for fractures distal end of radius in osteoporotic individuals.

Seven patients lost to follow up. Two patients migrated back to native place and remaining five refused to answer phone calls. In the final study group of 87 participants, there were 48 male (55.2%) and 39 female (44.8%) patients. Average age of male patients was 66 yrs (range 60 to 80 years) while that of female patients was 62 yrs (range 60 to 72 yrs). 78 patients had singh's index for osteoporosis grade 3 (90%) and 9 had grade 2(10%). Predominant mode of trauma being fall while walking indicating low velocity injuries – 72 patients (83%), 12 patients had road traffic accidents (13%) and 3 patient had fall from height of 20 feet(4%).78 patients were operated within 7 days of trauma and remaining 9 were operated after 7 days of trauma.4 patients had associated injuries – 3 had head injuries, 1 had L1 burst fracture with bladder involvement and 1 had fracture shaft femur. There were 26 AO type-A2 fractures (30%), 26 type-A3 fractures (30%), 7 type-C1 fractures (10%),and 26 type C2 fractures(30%).

Radiological parameters

Mean radial inclination immediate post reduction was 23 mm which was maintained throughout period of follow up of 24 weeks except in four patient. These pts had loss of reduction of radial inclination by 2 degree. Mean radial length immediate post reduction achieved was 11mm. Three patients had loss of radial length by 1 mm which was noted at 6 wk follow up. Further follow up till 24 wk did not shown further deterioration. Mean radial tilt immediate post op was 12 degree while ideal is 11 degree. Further follow up showed loss of reduction by 1 degree in four patients noted at 6 wks which did not deteriorate further. In three cases we were not able to achieve articular congruity intraoperatively. Quality of the initial postoperative radiographic reduction was close to anatomic parameters in this cohort and that the reduction was maintained at the 24 wks follow-up despite early range of motion of the wrist (fig 1).

Clinical parameters

At the end of 24 wks active pronation of the involved forearm averaged 66 Degrees which was 89% of uninjured forearm and active Supination averaged 63 degrees, which was 85% the contralateral forearm. Active palmar flexion of the involved wrist averaged 69 degrees i.e.95% of contralateral forearm and active dorsi flexion averaged 68 degrees i.e. 92% of the contralateral wrist. Active radial deviation of the involved wrist averaged 14 degrees which was 83% of contralateral wrist and active ulnar deviation averaged 15 degrees i.e. 85% the contralateral wrist. 12 had grip strength within 10% of that on contralateral side.62 patients had grip strength that was within 20% of that on the contralateral side; 6 within 30 per cent of that on the contralateral side; and 7 within 40 per cent of that on the contralateral side. Movement of wrist, forearm and grip strength showed progressive improvement from 6 wks to 24 wks. Majority of patients reached values comparable to contralateral wrist by 24 wks (fig 2).There were 14 (16.7%) excellent scores, 55 (63.3%) good,9 (10%) fair and 9(10%) poor functional scores at the end of 24 wks (table 5,6).Most of the functional outcomes showed continued improvement between the six weeks to

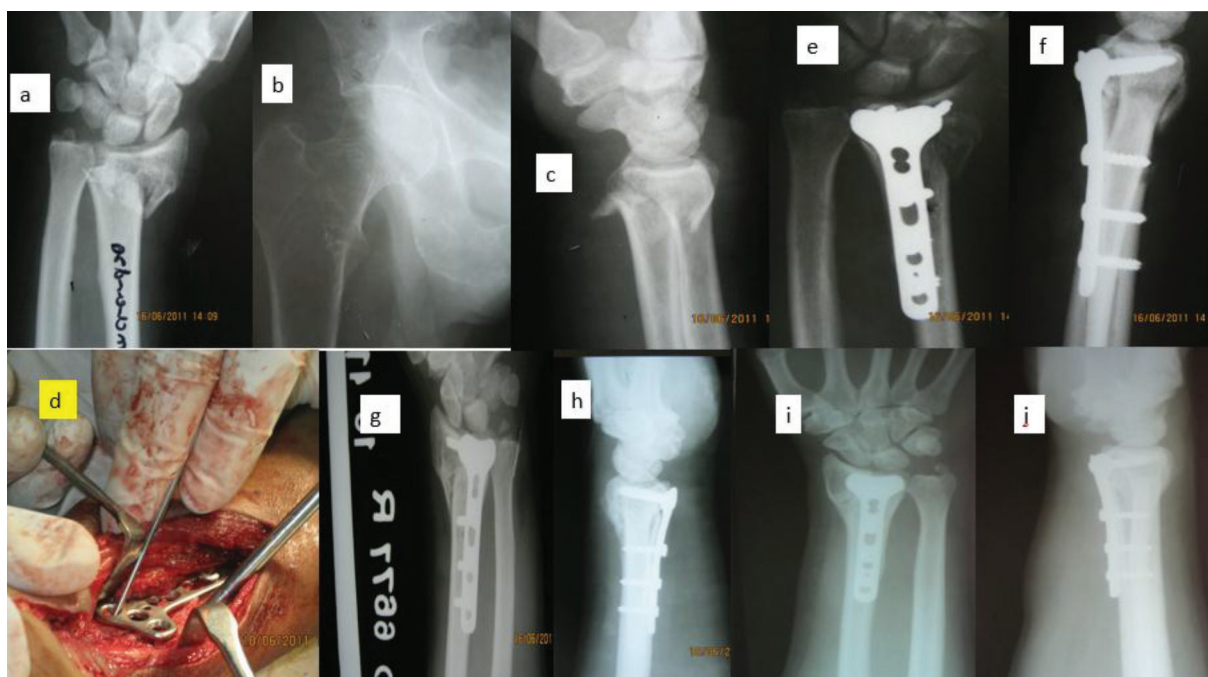


Figure-1: a - preop AP view. b – PBH AP view showing grade 3 singh index. c- preop lateral view. d- intraop picture. e- immediate postop AP. f- immediate post op LAT view showing radiological parameters restored. g- AP view 6 weeks follow up. h- lateral view 6 weeks follow up i- AP view 24 week follow up j- LAT view 24 week follow up showing union with no secondary loss of reduction

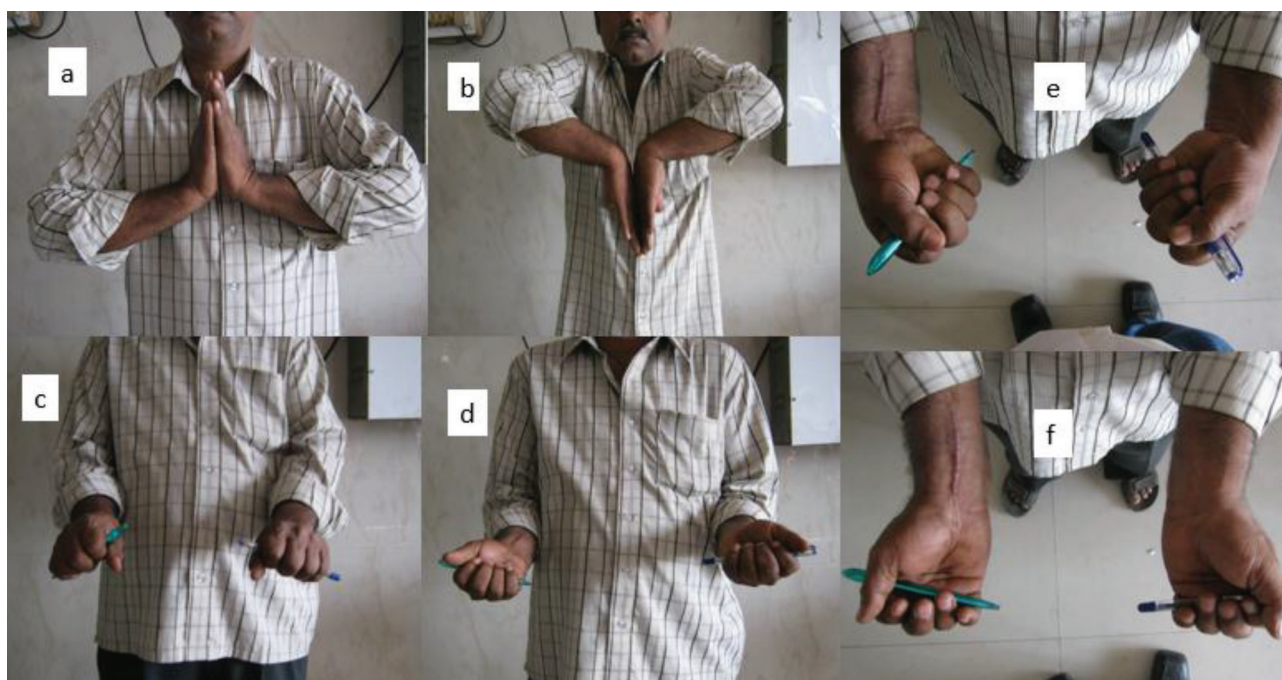


Figure-2: Functional outcomes at 24 weeks post surgery showing wrist range of motion equal to opposite side. a- palmar flexion, b- dorsiflexion, c- pronation, d- supination, e- ulnar deviation, f- radial deviation

twenty four weeks periods. Significant improvement over the 24 wk period was noted in terms of grip strength, flexion, extension, radial deviation and supination after adjusting for the outcome values for the normal side, age, and gender. The patient-rated outcome scores showed that most of patients achieved good functional scores at end of 24 wks. According to the mean difference between the injured and normal sides in terms of the overall score, a large improvement was seen from 6 wks to 24 wks.

Complication

Seventy eight patients had unremarkable perioperative period. Five patients had suture abscesses that resolved with suture removal, three patients developed sympathetic dystrophy which improved with physiotherapy of hand over a period of three months, and one patient had lingual trauma due to intubation.

DISCUSSION

The primary goal in treatment of unstable fractures of the

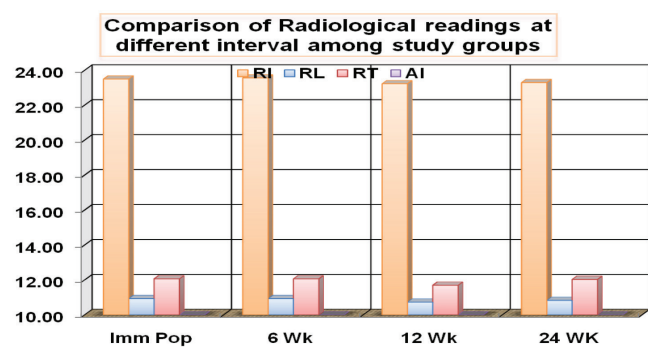


Figure-3: Radiological parameters at follow up showing maintenance of on table reduction in follow up period by volar locking plates. (RI- radial inclination, RL- Radial length, RT- Radial tilt, AI- Articular incongruity)

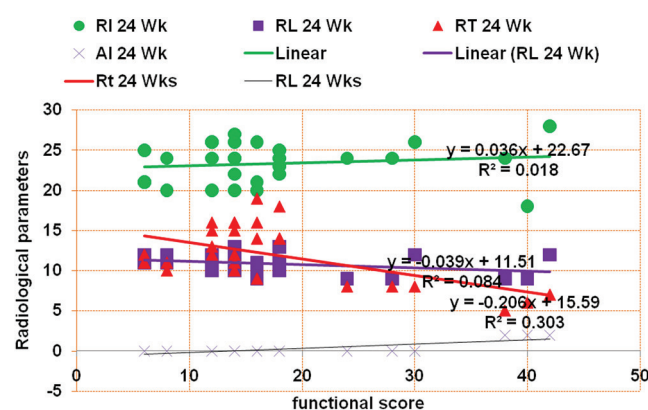


Figure-4: Correlation between functional scores and radiological parameters.

distal radius is to achieve optimal restoration of the disrupted anatomy and allow quick return of hand function, while preventing secondary fracture displacement. Though various modalities of treatment like cast immobilization, K wire fixation, external fixators have been used in treatment of distal radius fractures- these methods does not achieve optimal restoration of anatomy. To achieve optimal restoration of anatomy plating is best option. Nonlocking plate osteosynthesis depends on friction generated between plate and bone. As the screw head is forced into plate, potential energy is converted into friction. This friction creates load transfer path from bone to plate, across the fracture site and back to plate again. So screws should have good purchase in bone to create this friction. In osteoporotic bones due to decreased trabecular density screw purchase is poor, leading to poor fixation. Locking plate technology has overcome this problem by creating fixed angle construct which does not depend on purchase of screws.⁶

There were 54 (60%) patients with extra-articular fractures i.e. AO type A fractures while 33 (40%) had sustained intra-articular one i.e. AO type C fractures. This underlines fact that complex fracture patterns which are normally seen in high velocity injuries are commonplace in osteoporosis and can be caused by trivial trauma

Quality of the initial postoperative radiographic reduction was close to anatomic parameters in this cohort and reduction was maintained at the 24 weeks follow-up, despite

early range of motion of the wrist in 85% of individuals (fig 3). Similar to this study Kevin chung et al⁷ also observed that intraop reduction was maintained in postop follow up when volar locking plates were used. Cases where reduction was lost, had distal screw placement at a distance from subchondral plane. Subchondral placement of distal screws appears to help maintain reduction. Orbay et al had similar observation about subchondral placement of screws.⁸ Similar to our study Figl M et al also found that volar locking plates prevents secondary loss of reduction.⁹

Our patients were most pleased by their quick return of function and return to activities of daily living. The 24 wks PRWE scores obtained in this study shows a high degree of patient satisfaction. Early wrist motion has been shown to enhance hand and finger function.¹⁰ The final functional outcomes of the patients in our study are comparable to those of other reported series of open reduction and internal fixation.^{11,12}

Three factors were found associated with a fair or poor outcome. 1) Time period between injuries to operation, 2) Radial tilt 3) Articular incongruity. We observed that time between injuries to operation and articular incongruity showed negative correlation with functional outcome while radial tilt and functional outcome showed positive correlation (fig 4). These findings are similar to that of Jesse Jupiter et al.¹³ who observed inverse correlation between radial tilt and poor outcomes.

In this study we observed nine (10.35%) complications. five were suture abscesses which resolved on removing sutures while three patient developed reflex sympathetic dystrophy which responded to physiotherapy. One pt had anesthesia related complication in form of lingual trauma during intubation which resolved spontaneously. There were no cases of implant failure or prominent implant. Orbay¹⁴ had similar observation of low complication rates while Jesse Jupiter et al¹³ had observed very high complication rates. This may be attributed to improved surgical techniques in recent years.

In this series there were no tendon-related complications and all implants have remained in place. Chronic fractures and those with articular displacement could be adequately reduced and fixed. This was accomplished, when necessary, by using the extended flexor carpi radialis approach, performing a thorough fracture debridement, and directly or indirectly manipulating the fragments.

Complete recruitment and follow-up of all eligible subjects were not achieved in the present study because of the tendency for trauma patients to be noncompliant. We observed steady improvement in functional score from 6 wks to 24 wks. Study spanning more time period is necessary to comment on final outcome. We faced difficulties in teaching patients of exercises immediately post op and to ensure compliance to the same. Most patients were reluctant for physiotherapy exercises.

CONCLUSION

In view of the satisfactory results obtained with this series

we believe that this method represents a valuable treatment modality for the most frequent types of fractures of the distal radius in the osteoporotic patients. The surgical approach is simple and can be extended depending on the complexity of the fracture. The biomechanical features of the volar locking plate in combination with preservation of the vascularity of the dorsal comminuted area rendered additional bone grafting rarely necessary except for unusual cases of important dorsal and volar comminution seen with high-energy injuries. This technique minimizes morbidity in the elderly population by allowing an early return to function. It successfully handles osteopenic bone, provides good final results, and presents a low complication rate.

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