

Comparison of Functional and Radiological Outcome of Joshi's External Stabilization System Versus Volar Locking Compression Plate in Unstable Distal End Radius Fractures: A Short-term Prospective Study

Sandesh S Bobade¹, Sharma Shyoji², Bobade Satish³, Meena Pradeep⁴, Sonaje Jayesh⁵

¹Junior Consultant, Department of Orthopaedics, Bobade Accident Hospital, Baramati, Maharashtra, India, ²Professor, Department of Orthopaedics, SMS Medical College, Jaipur, Rajasthan, India, ³Senior Consultant, Department of Orthopaedics, Bobade Accident Hospital, Baramati, Maharashtra, India, ⁴Assistant Professor, Department of Orthopaedics, AIIMS Rishikesh, Rishikesh, Himachal Pradesh, India, ⁵Consultant, Department of Orthopaedics, Apollo Hospital, Madurai, India

Abstract

Purpose: The purpose of this study was to compare the short-term functional and radiological outcome between Joshi's external stabilization systems (JESSs) with volar locking compression plate (LCP) in treatment of unstable distal end radius fractures.

Materials and Methods: A prospective study was conducted which included a total of 50 patients between the age group of 20–60 years with fresh closed unstable distal end radius fractures and was randomized into two groups of 25 patients each and their outcomes were compared.

Results: The average period of follow-up was 2 years after which range of motion of the two groups was compared and clinical and radiological evaluation was done. The functional result according to modified Gartland and Werley scoring was excellent in 8%, good in 40%, fair in 48%, and poor in 4% in JESS group while it was excellent in 8%, good in 84%, fair in 4%, and poor in 4% in volar LCP group. According to Stewart scoring system, the result was excellent in 8%, good in 40%, fair in 48% cases, and poor in 4% cases in JESS group while it was excellent-good in 88%, fair in 8%, and poor in 4% in the LCP group.

Conclusions: The mean time to union was 5.71 months in volar LCP group and 3.75 months in JESS group. The functional and anatomical evaluation of both the groups showed that fixation by volar LCP group had better result in comparison to external fixation by JESS with accurate maintenance of articular margin. Better functional results can be expected in the early post-operative period in association with open reduction and internal fixation, and this form of treatment should be considered for patients requiring a faster return to function after the injury, but in the long run, this is comparable with JESS fixation.

Key words: Closed reduction distal radius, Distal radius fractures, Joshi's external stabilization system fixator, Locking compression plate, Volar Barton's fracture

INTRODUCTION

Distal radius fractures are very common injuries accounting for 16% of all fractures treated in emergency room and represent 74.5% of all fractures of the forearm.^[1] Since Abraham Colles' original description of this injury in

1814,^[2] more than 4000 articles have been published relating to distal radius fractures and their treatment. Many fixation techniques have been described including pin and plaster fixation,^[3] percutaneous pinning and intramedullary pinning,^[4] external fixation (bridging or non-bridging, static, or dynamic),^[5] injectable bone cement,^[6] and various forms of internal fixation with customized implants^[7] and have their merits and demerits. Among external fixation and plating, none have been found to be superior than other in recent trials.^[8] This has led us to directly compare the result of the two methods of treatment in intra-articular fractures of distal end of radius and compare their functional outcome, radiological outcome, and complications.

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Corresponding Author: Dr. Sandesh S Bobade, Harikrupa Nagar, Indapur Road, Opp. Market Yard, Baramati, Pune, Maharashtra, India.

MATERIALS AND METHODS

Study Group

The protocol was approved by the local ethics committee and written informed consent was obtained from each patient. This study was conducted in our hospital from January 2011 to July 2013 and included 50 patients with intra-articular distal radius fracture AO Type 23C3, with skeletal maturity (>18 years) and giving written informed consent, randomized into JESS and volar locking compression plate (LCP) with 25 patients each. The patients having old (>2 weeks), open fractures, pre-existing wrist disability, infection, or mental incompetence were excluded from the study. These patients were followed at 2 and 6 weeks, 3, 6, 9, and 12 months. Follow-up examination consisted of range of motion (ROM) measurements by Gartland and Werley demerit criteria^[9] modified by Sarmiento^[10] and radiographic evaluation by Stewart criteria,^[11] respectively. The X-rays were evaluated for articular congruity of the distal radius, radial inclination, ulnar variance, volar–dorsal tilt, and osteoarthritic changes of the radiocarpal joint. Articular incongruity was arbitrarily defined as a step off or a gap of at least 2 mm.

Surgical Technique

The patients were given a general anesthesia or regional anesthesia and were positioned in the supine position. We routinely used a pneumatic tourniquet, fluoroscopic imaging, and a pre-operative prophylactic intravenous antibiotic.

JESS

The patient was placed supine on OT table with affected upper limb abducted and slightly flexed at elbow joint and forearm mid pronated. Two Schanz pins were inserted, first the proximal one on radius 90° to dorsal surface and the distal one through the base of the second metacarpal from dorsal surface. Fracture was reduced by giving traction by holding index finger and middle finger and keeping the wrist in slight dorsiflexion and ulnar deviation. JESS was fixed over the two pins and fixed by screw. Another proximal and distal Schanz pin fixed through the JESS and screws were tightened. Then, distraction of JESS was done by tightening the screw. Pin tract dressing was done and forearm slab was applied.

Volar locking plate

The surgical approach was through the sheath of the flexor carpi radialis tendon. The LCP T-plate or oblique distal radius plate was used. The plate was applied to the volar aspect of the distal radius under direct vision and fixed proximally using the oblong hole to allow fine adjustment, the fracture was reduced and temporary fixation was maintained with K-wires. The reduction and plate position

were routinely checked under image intensification. Distal locking screws were subsequently sited so as to reach but not penetrate the dorsal cortex. A measurement of 2 mm was routinely subtracted from the distal screw length measurement to avoid penetration of the dorsal cortex and to minimize the potential for extensor tendon irritation. Distal locking screws were positioned aiming to site them 2 mm below the joint line to provide subchondral support.

Statistical Analysis

The data were analyzed using computer statistical software (Microsoft Excel, IBM Corp, released 2011 and primer). Descriptive statistics (mean, standard deviation, and proportions) were used to summarize the study variables. The 95% confidence intervals for difference of mean were used. Chi-square test was used to observe an association between the qualitative study and outcome variables. Unpaired *t*-test was used for analysis of quantitative data. Power analysis showed that the sample size able to detect an effect size of 0.75, with power and level of significance fixed at 80% and 5%, respectively, was minimum of 17 subjects in a group. The level of significance was set at $P < 0.05$.

OBSERVATION AND RESULTS

The mean age was 42 (range 23–60) years and 38 (range 22–58) years in JESS group and LCP group, respectively, with 80% of males in JESS group and 88% in LCP group.

Laterality

The right side was injured in 72% of patients in JESS group and 80% of patients in LCP group.

Mechanism of Injury

Fall on outstretched hand from a standing height was the most common mechanism of injury, reported by 90% in JESS group and 88% in LCP group followed by road traffic accident.

Union

The mean time to clinical and radiological signs of union was 3.75 months in JESS group and 5.71 months in LCP group.

Fracture Type

According to AO classification, type C2 fracture was most common in both the groups followed by type C1 and type C3. The time to union was 2–3 months in 84% of cases in JESS group, while 52% of cases required 3–4 months and 40% required 2–3 months to unite in LCP group.

ROM

The ROM at 1 year follow-up with respect to palmar flexion, dorsiflexion, supination, pronation, radial deviation, ulnar

deviation, and grip strength was 66.96 ± 6.95 , 56.52 ± 8.99 , 79.04 ± 9.16 , 69 ± 7.45 , 13.76 ± 3.07 , 25.48 ± 3.78 , and 78.84 ± 9.84 , respectively, in JESS group and 67.48 ± 8.54 , 57.12 ± 5.68 , 80.76 ± 8.19 , 70.2 ± 5.21 , 14.12 ± 2.5 , 25.96 ± 4.63 , and 79.88 ± 11.72 , respectively, in LCP group.

Radiological Parameters at 1 Year Follow-up

The radial height, palmar tilt, and articular step off of 11.28 ± 2.44 mm, 4.08 ± 6.1 deg, and 0.76 ± 0.84 were noted in JESS group compared to 12.16 ± 2.73 mm, 6.48 ± 7.14 deg, and 0.66 ± 0.60 mm, respectively, in LCP group.

Functional Outcome

The functional result according to modified Gartland and Werley scoring was excellent in 8%, good in 40%, fair in 48%, and poor in 4% in JESS group while it was excellent in 8%, good in 84%, fair in 4%, and poor in 4% in volar LCP group.

Radiological Outcome

According to the Stewart scoring system, 2 (8%) cases showed excellent result with JESS, 10 (40%) cases having good result, 12 (48%) cases with fair, and 1 (4%) case with poor result while the LCP group showed 22 (88%) cases with excellent-good result and 2 (8%) cases with fair and 1 (4%) case with poor result.

Distribution of Outcome According to Fracture Type

In JESS group, of seven cases with type C1 fracture, four had good and three had fair outcome; of 10 patients with type C2, five had good, four had fair, and one had poor outcome; of seven patients with type C3, two had excellent, one had good, and four had fair outcome while in LCP group, of eight cases with type C1 fracture, two had excellent and six had good outcome; of 12 patients with type C2, 10 had good, one had fair, and one had poor outcome; of three patients with type C3, all had good outcome.

Complications

In JESS group, 4% of cases had pin tract infection, 2% had pin loosening, and 2% had neuropraxia of sensory branch of radial nerve. About 8% of patients had malunion after removal of JESS. About 10% of patients had finger and wrist stiffness in both JESS and volar LCP due to prolonged immobilization and inadequate physiotherapy, which was treated by regular exercises and these patients had fair result at 1 year follow-up.

DISCUSSION

Intra-articular fractures of the distal end of radius represent complex, unstable injury and the treatment remains controversial.^[12] The main objective of its treatment is the

reestablishment of anatomic integrity and functioning. Both external fixation and plating have shown to have satisfactory results.^[13] A better understanding of wrist anatomy and functioning through the studies conducted in recent years,^[14,15] as well as the increasing expectations of patients has expanded the borders of surgical treatment. Today, open reduction and plate fixation are the widely recognized surgical methods.^[16,17] Locked plates are in the progress of replacing conventional support plates. While facilitating the positioning, those anatomical plates with screw plate interlocking feature have more biomechanical strength against forces applied on the fracture surfaces and work as internal fixator. Due to their biomechanical strength, locked plates are preferred in osteoporotic and/or multiple fractures.^[18,19]

External bridging fixation is modality of treatment long before when plating came in scenario^[20,21] and is still preferred by many surgeons as a familiar technique as it requires minimal exposure and is less time consuming with low learning curve.^[22-24]

Various studies have been conducted using multiple measuring criteria to compare external fixation and plating and have shown comparable results.^[8,25] Egol *et al.*,^[8] in 280 patients, found an improved range of movement early after volar plating, but after 1 year, the range of movement between the groups was similar, as were the results for grip strength and DASH scores at all-time points. In our study, the LCP group showed advantage of early mobilization at 3-month follow-up as compared to JESS group but eventually at 9 months of follow-up both the groups showed comparable results. Patients in the open reduction and internal fixation group had greater ROM and strength than patients in the closed reduction and JESS at 6 and 9 months, and more patients in the open reduction and internal fixation group were very satisfied with the overall wrist function and motion. In our study, anatomical and radiological parameters were better restored in volar LCP group, but this was not significant when compared with JESS group. Moreover, the concept of anatomical restoration is still under debate as it has not been shown to have association with functional outcome.^[26,27] Mean time for union was less in JESS group when compared to volar LCP group. In our study, despite complications such as pin loosening, infection JESS group showed to have comparable results with LCP group.

Limitations

Our study had several limitations. Our study was focused and DALY and DASH score, workers' compensation were not taken into consideration, inclusion of which could have made this study better. Furthermore, sometimes while difficulties to apply scoring system accurately, particularly

for the radiological and subjective demerit points, might cause wide variance of results in groups with apparently comparable radiological and clinical findings. Another limitation of this study was difficulty in maintaining patient follow-up despite various protocols. However, the follow-up rates were comparable with other randomized controlled trials 8. Furthermore, the primary objective to compare functional and radiological outcomes did not show significant difference at 1 year follow-up, long-term changes such as radiocarpal arthritis could not be encountered which could further add to the outcome of the study.^[28,29] A comparative trial with longer follow-up would allow evaluation of potential long-term sequelae.

CONCLUSIONS

Better functional results can be expected in the early post-operative period in association with open reduction and internal fixation, and this form of treatment should be considered for patients requiring a faster return to function after the injury, but in a long run, this is comparable with JESS fixation.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

REFERENCES

1. MacIntyre NJ, Dewan N. Epidemiology of distal radius fractures and factors predicting risk and prognosis. *J Hand Ther* 2016;29:136-45.
2. Colles A. On the fracture of the carpal extremity of the radius. *Edinb Med Surg J* 1814;10:182-6.
3. Chen CE, Juhn RJ, Ko JY. Treatment of distal radius fractures with percutaneous pinning and pin-in-plaster. *Hand (N Y)* 2008;3:245-50.
4. Alluri R, Longacre M, Pannell W, Stevanovic M, Ghiassi A. Volar, intramedullary, and percutaneous fixation of distal radius fractures. *J Wrist Surg* 2015;4:292-300.
5. Krukhaug Y, Uglund S, Lie SA, Hove LM. External fixation of fractures of the distal radius: A randomized comparison of the Hoffman compact II non-bridging fixator and the dynawrist fixator in 75 patients followed for 1 year. *Acta Orthop* 2009;80:104-8.
6. Neral M, Solari M, Purnell C, Wollstein R. The use of bone cement in difficult distal radius fractures. *Hand (N Y)* 2013;8:387-91.
7. Taras JS, Ladd AL, Kalainov DM, Ruch DS, Ring DC. New concepts in the treatment of distal radius fractures. *Instr Course Lect* 2010;59:313-32.
8. Egol K, Walsh M, Tejwani N, McLaurin T, Wynn C, Paksima N, *et al.* Bridging external fixation and supplementary kirschner-wire fixation versus volar locked plating for unstable fractures of the distal radius: A randomised, prospective trial. *J Bone Joint Surg Br* 2008;90:1214-21.
9. Gartland JJ Jr., Werley CW. Evaluation of healed Colles' fractures. *J Bone Joint Surg Am* 1951;33-A:895-907.
10. Sarmiento A, Pratt GW, Berry NC, Sinclair WF. Colles' fractures. Functional bracing in supination. *J Bone Joint Surg Am* 1975;57:311-7.
11. Stewart NR, Gilula LA. CT of the wrist: A tailored approach. *Radiology* 1992;183:13-20.
12. Chen NC, Jupiter JB. Management of distal radial fractures. *J Bone Joint Surg Am* 2007;89:2051-62.
13. Handoll HH, Madhok R. Surgical interventions for treating distal radial fractures in adults. *Cochrane Database Syst Rev* 2003;3:CD003209.
14. Obert L, Loisel F, Gasse N, Lepage D. Distal radius anatomy applied to the treatment of wrist fractures by plate: A review of recent literature. *SICOT J* 2015;1:14.
15. McCann PA, Clarke D, Amirfeyz R, Bhatia R. The cadaveric anatomy of the distal radius: Implications for the use of volar plates. *Ann R Coll Surg Engl* 2012;94:116-20.
16. Earp BE, Foster B, Blazar PE. The use of a single volar locking plate for AO C3-type distal radius fractures. *Hand (N Y)* 2015;10:649-53.
17. Jose A, Suranigi SM, Deniese PN, Babu AT, Rengasamy K, Najimudeen S, *et al.* Unstable distal radius fractures treated by volar locking anatomical plates. *J Clin Diagn Res* 2017;11:RC04-RC08.
18. Trease C, McHff T, Toby EB. Locking versus nonlocking T-plates for dorsal and volar fixation of dorsally comminuted distal radius fractures: A biomechanical study. *J Hand Surg Am* 2005;30:756-63.
19. Gondusky JS, Carney J, Erpenbach J, Robertson C, Mahar A, Oka R, *et al.* Biomechanical comparison of locking versus nonlocking volar and dorsal T-plates for fixation of dorsally comminuted distal radius fractures. *J Orthop Trauma* 2011;25:44-50.
20. Sommerkamp TG, Seeman M, Silliman J, Jones A, Patterson S, Walker J, *et al.* Dynamic external fixation of unstable fractures of the distal part of the radius. A prospective, randomized comparison with static external fixation. *J Bone Joint Surg Am* 1994;76:1149-61.
21. Weiland AJ. External fixation, not ORIF, as the treatment of choice for fractures of the distal radius. *J Orthop Trauma* 1999;13:570-2.
22. Payandeh JB, McKee MD. External fixation of distal radius fractures. *Orthop Clin North Am* 2007;38:187-92, 6.
23. Akmaz I, Pehlivan O, Kiral A, Solakoğlu C, Arpacioğlu O. Short-term results of external fixation of unstable distal radial fractures. *Acta Orthop Traumatol Turc* 2003;37:126-32.
24. Kulshrestha V, Roy T, Audige L. Dynamic vs static external fixation of distal radial fractures: A randomized study. *Indian J Orthop* 2011;45:527-34.
25. Wilcke MK, Abbaszadegan H, Adolphson PY. Wrist function recovers more rapidly after volar locked plating than after external fixation but the outcomes are similar after 1 year. *Acta Orthop* 2011;82:76-81.
26. Synn AJ, Makhni EC, Makhni MC, Rozental TD, Day CS. Distal radius fractures in older patients: Is anatomic reduction necessary? *Clin Orthop Relat Res* 2009;467:1612-20.
27. Padegimas EM, Osei DA. Evaluation and treatment of osseoporotic distal radius fracture in the elderly patient. *Curr Rev Musculoskelet Med* 2013;6:41-6.
28. Catalano LW 3rd, Cole RJ, Gelberman RH, Evanoff BA, Gilula LA, Borrelli J Jr., *et al.* Displaced intra-articular fractures of the distal aspect of the radius. Long-term results in young adults after open reduction and internal fixation. *J Bone Joint Surg Am* 1997;79:1290-302.
29. Goldfarb CA, Rudzki JR, Catalano LW, Hughes M, Borrelli J Jr. Fifteen-year outcome of displaced intra-articular fractures of the distal radius. *J Hand Surg Am* 2006;31:633-9.

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