

Comparison of the functional outcome for Joshi External Stabilising System Fixator Versus Volar Plating in Treating Closed Intra-Articular Distal End Radius Fracture

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ABSTRACT

Introduction: Fracture involving distal end of radius is the most common fracture of upper extremity and its incidence is expected to increase with an aging population. The Joshi External Stabilising System (JESS) has been used for bone stabilisation in the Indian subcontinent for last 30 years. The aim of this prospective study was to analyse the functional outcome of management for fractures of distal end radius using volar plate fixation compared to JESS fixation. We hypothesize that volar plate fixation gives better functional and anatomical outcomes as compared to JESS.

Material and Methods: Forty consecutive cases of distal end of radius fracture, meeting the inclusion criteria were recruited and alternately treated with either treatment modality.

Results: The plating group showed statistically better functional outcome compared to the JESS group.

Conclusion: Plating gives better functional results as compared to JESS fixator and allows for early mobilisation of patients. The grip strength is better in the plating group as compared to JESS group. No need of implant removal, better grip strength after long term follow-up are some of the advantages of JESS fixation and remains a good treatment option for distal end radius fractures.

Keywords: External Stabilising, Volar Plating, Intra-Articular Distal, End Radius Fracture

treating contractures of the hand and wrist and interphalangeal joint due to burns and due to diseases like leprosy. It was later used in intra-articular distal radial fractures, idiopathic clubfoot, calcaneal fractures, and congenital talipes equinovarus. It assists the surgeon in obtaining fracture stabilisation and helps in fracture healing by gradual and controlled distraction and works on the principle of ligamentotaxis.⁴

In distal radius fractures with articular incongruity where reduction is difficult to achieve and then maintain via external manipulation and ligamentotaxis, open reduction internal fixation is indicated, provided sufficient bone stock is present to permit early range of motion.

The purpose of this study was analyze the anatomical and functional outcome of operative management for fractures of distal end radius using open reduction and internal fixation with plates and screws as compared to JESS fixation (Joshi's External Stabilisation System).

MATERIAL AND METHODS

Institutional review board and ethical committee approval was obtained for the study. Study was conducted in Dr. D.Y. Patil Hospital and Research Centre September 2012 to November 2013.

This was a Prospective study of forty cases of distal end of radius fracture who presented to our hospital during the above mentioned study period.

Forty consecutive cases of distal end of radius fracture, meeting the eligibility criteria were selected and alternately treated with either treatment modality.

Total 40 patients satisfying the criteria were treated and followed up from admission to post-operative period and rehabilitation and beyond. Minimum postoperative follow up was of 2 months and maximum of 14 months.

AO Classification was used to classify the fracture pattern. Various measurements were taken including radial tilt, radial

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length, shortening, intra-articular extention, DRUJ space and articular congruity.

Out of 40 selected patients, 20 were treated by open reduction and internal fixation and 20 by JESS. The patients were randomly selected for a particular treatment option.

Surgical Procedure

The duration from date of injury to the date of operation ranged from 1-10 days. 40 Consecutive cases of distal end of radius, meeting the eligibility criteria were alternately treated with either Plating or JESS fixation. Volar approach was used for plating. Implant Used for plating: Non-locked palmar Ellis T-plate with 3.5 mm screws was used for ORIF with plating. JESS was used as the method of external fixator.

Post-Operative Care and rehabilitation

Post-operative pain and inflammation were managed using anti-inflammatory analgesics. Affected limb was kept elevated and patients were asked to perform active finger movements, elbow and shoulder movements from day one. Dressings were changed on the 5th post-operative day. Immediate post operative check X-rays were taken in both PA and lateral views. Fracture reduction was confirmed and displacements were noted.

For patients treated with JESS fixator, the pin sites were cleaned with spirit and povidone iodine on alternate days for further 3-5 days. Patients were discharged after the 3rd to 10th postoperative day depending on the condition of the patient and operative wound. Patients were encouraged for active finger mobilisation at metacarpophalangeal and interphalangeal joints and flexion /extension at elbow and shoulder movements were started from second post operative day.

For patients treated with Open Reduction and Internal Fixation, after the surgery, the operated limb was supported with a below elbow anterior splint. Wound was inspected on the 5th post-operative day. Sutures were removed on the 10th post-operative day. The patients were advised not to lift heavy weights for further 4 to 6 weeks.

Patient were followed up after 15 days for pain, swelling, pin tract infection, pin loosening and stiffness of fingers, elbow or shoulder. On follow-up at 6th week, the fracture union was assessed clinically by absence of tenderness and radiologically by bridging callus formation. Then the external fixator and 'K' wires, if any, were removed under general anaesthesia or on out patient basis in the minor operation theatre. The patients were advised not to lift heavy weights for further 4 to 6 weeks.

After discharge, all patients were reviewed weekly for the first 6 weeks. Patients were assessed subjectively for pain at the fracture site, clinically for tenderness, loosening of the pins (external fixator cases) and any signs of infection. Pronation and supination of the forearm and active movement of the elbow and shoulder were advised throughout the period of healing. After the 6th week, physiotherapy was started, which include flexion - extension, adduction abduction and pronation supination exercises along with underwater exercises. The range of wrist movements were recorded and any deformity assessed. Follow – up radiographs were taken at 3 months, 6 months and final follow up at one year and after each realignment of JESS fixator.

Follow up Schedule: 6 weeks, 3 months, 6 months, 9 months and 12 months (maximum of 14 months).

Evaluation of results

Results were assessed using:

- Functional assessment was done comparing Range of motion (using goniometer) and Grip strength (as compared to opposite normal wrist) and using Cooney modification of the Green and O'Brien score.^{5,6}
- Radiological assessment was done comparing Radial Length (mm), radial inclination (°), Palmar tilt (°) and articular incongruity. A radiological score was derived from the above measurements—in this study, Sarmiento et al's modification of the Lidström and Frykman radiological classification was used.⁷

STATISTICAL ANALYSIS

The following method of statistical analysis have been used in this study. The excel and SPSS-version 16 software (SPSS Inc., Chicago, IL, USA) was used for data entry and analysis. The results were averaged (mean + standard deviation) for each parameter for continuous data in table and figure. The students t test was used for comparative analysis between two groups. In all the above test a "p" value of less than 0.005 was accepted as indicating statistical significance.

All the data was entered systematically in an excel sheet under proper headings. The data was analysed using descriptive statistics and the representation of the same was done in percentages.

RESULTS

Majority of patients 16 (40 %) were between 51-60 age group and between 21-30 age group-14 (35%) showing a bimodal distribution. Most of the patients were male (55%). Out of 40 patients, 23 (57.5%) patients had left side and 17 (42.5%) patients had right side involvement.

In present study, fall on outstretched hand was the most common mechanism of injury seen in 21 (52.5%) patients out of 40. 08 of these 40 cases (20%) had associated injuries. Fracture tibia was treated with closed reduction and Interlocking nailing. For elbow dislocation, closed reduction was done successfully. Scapula and clavicle fracture were successfully treated conservatively. Contusional head injury managed conservatively and emergency laprotomy was done in one case of abdominal injury for hemoperitoneum.

In present study, 18 (45%) patients were having Osteoporosis, 15 (37.5%) had Diabetes Mellitus and 10 (25%) had Hypertension. 20 (50 %) patients were suffering from more than one medical condition. Out of 40 cases, 02 (5%) cases were AO type B1, 07 (17.5%) were B2 type and 11 (27.5%) were B3 type. In the type C fracture pattern, 06 (15%) cases were C1 type, 10 (25%) were C2 and 04 (10%) were C3 type. Majority were B3 type followed by C2 (Table-1).

Duration of fracture union

In the present study, 34 (85%) patients had union within 2-3 months and 06 (15%) patients had union in 3-4 months. Surgery was done between 1-5 days in 38 (95%) of patients and was delayed to 6-10 days in 02 (5%) patients because one presented to us 4 days after injury and had uncontrolled diabetes mellitus and other case underwent emergency laprotomy for hemoperitoneum, 07 days after that he was operated for distal end radius fracture. Majority of patients were operated between 1-5 days.

Functional outcome in Plating and ORIF group

In present study, statistically significant functional result ($p < 0.05$) was seen in the Plating group in Extension, Flexion, Supination, Radial and Ulnar deviation as compared to JESS (Tables 2 and 3).

Functional results in the AO type C fracture pattern

In type B fracture pattern, we got excellent and good results in 04 (20%) patients in the JESS group and 08 (40%) patients in the plating group. Fair results were seen 06 (30%) patients in the JESS group and 02 (10%) patients in the plating group.

AO Fracture type	No. of cases	Surgical management	
		JESS	ORIF with plating
B1	02	01	01
B2	07	03	04
B3	11	06	05
C1	06	03	03
C2	10	05	05
C3	04	02	02
Total		20	20

Table-1: Modality of treatment used for each fracture pattern

Type of fracture (total no of patients)	Treatment	Anatomical Result			
		Excellent	Good	Fair	Poor
B1(02)	JESS	01	-	-	-
	OR and plating	01	-	-	-
B2(07)	JESS	01	-	02	-
	OR and plating	03	01	-	-
B3(11)	JESS	-	02	04	-
	OR and plating	03	02	-	-
C1(06)	JESS	-	03	-	-
	OR and plating	02	01	-	-
C2(10)	JESS	02	03	-	-
	OR and Plating	02	03	-	-
C3 (04)	JESS	-	02	-	-
	OR and Plating	-	01	01	-
Total (40)		15 (37.5%)	18 (45%)	07 (17.5%)	

Table-2: Anatomical results (sarmiento⁷) as per fracture pattern

Type of fracture (no of patients)	Treatment	Green and O'brein point system Functional results			
		Excellent	Good	Fair	Poor
B1(02)	JESS	01	-	-	-
	OR and plating	01	-	-	-
B2(07)	JESS	-	01	02	-
	OR and plating	03	-	01	-
B3(11)	JESS	01	01	04	-
	OR and plating	03	01	01	-
C1(06)	JESS	-	01	02	-
	OR and plating	02	01	-	-
C2(10)	JESS	02	01	-	02
	OR and Plating	02	02	01	-
C3 (04)	JESS	-	02	-	-
	OR and Plating	-	01	01	-
Total (40)		15(37.5%)	11(27.5%)	12(30%)	02(5%)

Table-3: Functional results as per fracture pattern

Functional and Radiological Scores	JESS	ORIF with plating	P score
Radial length (mm)	11.1(SD=2.29)	12 (SD=2.10)	0.203
Radial Inclination (°)	16.9(SD=3.93)	17.9(SD=3.74)	0.41
Palmar Tilt(°)	1.5 (SD=4.77)	6.15(SD=3.40)	0.001*
Grip Strength (% of contralateral side)	81.75(SD=12.27)	92.75(SD=9.66)	0.003*
Green and O'Brein Score	76.5(SD=14.78)	89.5(SD=12.96)	0.005*
Therapy Sessions (weeks)	10(4-20)	4(1-10)	0.01*

*Result is statistically significance ($p < 0.05$)

Table-4: Comparison of radiological outcome and functional scores

In type C fracture pattern, we got excellent and Good results in 05 (25%) patients in the JESS group as compared to 08 (40%) in the plating group. Fair result was seen in 02 (10%) patients in JESS group and 03 (15%) patients in Plating group. Poor functional result was seen in 02 (10%) patients in JESS group.

Overall Functional results in the two treatment modalities

In present study, we got excellent functional results according to the G and O'Brein system in 11 (55%) of patients treated with ORIF with plating group as compared to 4 (20%) patients in the JESS group (Table-4).

We got good results in 5 (25%) patient in Plating group as compared to 6 (30%) in the ORIF group. We got fair results 08 (40%) of patients in the JESS group as compared to 4 (20%) of patients in the ORIF group and poor result in 2 (10%) patients of the JESS group and none in the plating group.

Palmar tilt was better restored in the plating group as compared to the JESS group ($p<0.05$). In the present study, grip strength was significantly better ($p=0.003$) in the plating group as compared to the JESS group. We found statistical difference in the functional outcome as per the G and O'Brein score, which was better in the plating group as compared to the JESS group. The Physical therapy sessions required for plating group (1-10 weeks) was significantly less as compared to that for the JESS group (4-20 weeks) of the patients with a statistical significance ($p = 0.01$). In our series, we found that the range of motion (ROM) (Flexion-extension, Supination-Pronation, radial and Ulnar deviation) was better in the plating group as compared to the JESS group. In the JESS group the ROM improved over the follow-up period being comparable to plating group at the end of 12 months follow-up. The grip strength was significantly better in the Plating group in the initial follow-up period (6wks, 3months) but later improved in the JESS group. The Functional score of G and O'B'rein was considerably better in the Plating group in the initial part of the follow-up, which later improved in the JESS group over a period of 12 months of follow-up.

Complications

In present study, we observed complications in 09 (45%) of patients in the JESS group as compared to 02 (10%) patients in the plating group. Pin tract infection was seen in 03 (15%) patients in the JESS group, was superficial and was treated with daily cleaning, dressing and course of oral antibiotics. 01 (5%) patient in the JESS group had deformity, but he was not willing for corrective surgery and was satisfied with the functional result considering his activity level. Reflex sympathetic dystrophy (RSD) was seen in one patient (5%) in the JESS group and was managed conservatively. Wrist and finger stiffness was initially seen in all patients treated with JESS fixation after frame removal, which later resolved in most with physiotherapy. Stiffness was seen to be persistent in patients non-compliant with physiotherapy and was seen to be persistent in 02 (10%) patients in the JESS group and 01 (5%) patient in the ORIF with plating group. Shoulder hand syndrome was seen in 01 (5%) patient in the JESS group, which was managed with physiotherapy in the form of shoulder mobilisation exercises. One of the patient with AO type B2 fracture was initially treated with JESS fixation later required revision surgery with volar plating. There were no neurological complications. There were no Intraoperative complication. The other complications related

to external fixators like pin loosening, pin breakage, pullout of pins, carpal tunnel syndrome, neuroma of sensory branch of median nerve, stress fracture at the pin site were not observed in the present study.

DISCUSSION

Distal end of radius fracture remains one of the most challenging fractures to treat. There is no consensus regarding the description of the condition. Type of fracture, functional demand, existing bone stock and medical co-morbidities are factors which need to be studied before deciding the operative method.

Many surgical techniques of fracture fixation like external fixators, K-wires and plates are described. Open reduction and volar plating is an accepted surgical procedure for both extra articular as well as intra articular palmar angulated distal radius fractures. Fixing fractures with dorsal displacement however were considered biomechanically unfavourable. We assessed the functional outcome of operative management of distal radial fractures using JESS as compared to open reduction internal fixation with plating, evaluated our results and compared them with those obtained by various other studies utilising different modalities of treatment.

In the present study majority of the patients 16 (40%) were between 51-60 age group which is comparable to the studies of Bradway et al⁸, Jupiter JB et al⁹ and Kapoor H et al¹⁰, who had an average of 40 years, 42 years and 39 years respectively. Our study had 55% male patients and 45% female patients and maybe attributed to higher incidence of males involved in outdoor activities, labour work and riding vehicles. The left side was involved in majority (57.5%) of cases in our study.

The series of Jupiter JB et al⁹ and Kapoor H et al¹⁰ had increased involvement of the right wrist. But Bradway JK et al⁸ had equal involvement of both wrist in their study. Catalano LW et al¹¹ had increased involvement of the left wrist in their series which was also seen in our series.

In our study 21 (52.5%) patients had a history of fall on outstretched hand and 19 (47.5%) patients had a history of road traffic accident. Bradway JK et al⁸ and Catalano LW et al¹¹ reported fall on outstretched hand as the most common mode of injury, similar to that seen in our series.

We used AO classification in our series. Though AO classification is not always regarded as being the most precise classification system. However, in 2003, a study illustrated that it is the second most detailed classification after the Cooney classification.¹² In our study fractures were easily classified using the AO classification.

N.Schmelzer Schmied et al¹³ retrospectively evaluated 45 patients of distal end radius, AO type C1/C2. We studied in our series 40 patients of distal end radius falling in the category of AO type B and type C for distal end radius fractures.

In our study 20 patients underwent JESS fixation and the other 20 were operated with open reduction internal fixation with plating. In the series of Bradway JK et al⁸, Catalano and LW et al¹¹ more cases underwent open reduction internal fixation. In the series of Kapoor H et al¹⁰ there were equal number of cases treated with ORIF and EF. Their findings are comparable to our study.

In the present study we observed complication rate of 45% in the JESS group of patients as compared to 10% in the Plating

group. The JESS group had the complications in the form of pin tract infection in 03 (15%) patients, deformity in 01 (5%) patient, reflex sympathetic dystrophy in 1 (5%) patient, persistent wrist and finger stiffness in 02 (10%) patients and Shoulder hand syndrome was seen in 01 (5%) patient. One of the patient with AO type B2 fracture was initially treated with JESS fixation later required revision surgery with volar plating because of failure to get reduction. In the plating group, we observed shoulder stiffness 1 (5%) of the patient and residual wrist and finger stiffness in 01 (5%) patient because of lack of compliance with physiotherapy.

Bradway JK et al⁸ and Jupiter JB et al⁹ reported a complication rate of 30% and 36% respectively. N.Schmelzer et al¹³ reported a complication rate of 46.67% in the external fixator group as compared to 10% in the plating group, which is comparable to our study. But they had also compared non-locked and locking palmar plating, which was not done in our current series.

In present study, we got excellent functional results according to the G and O'Brein Functional scoring system in 11 (55%) patients treated with Plating as compared to 4 (20%) patients in the JESS group, good results in 5 (25%) patients in the plating group as compared to 06 (30%) patients in the JESS group. We got fair result in 8 (40%) patients in the JESS group as compared to 4 (20%) patients in the Plating group. We got poor result in 2 (10%) patients of the JESS group and none in the plating group. There was a significant difference in the mean value of the functional result in the plating group (76.5) as compared to JESS group (89.5).

We got excellent anatomical results in 11 (55%) patients in the plating group as compared to 04 (20%) patients in the JESS group, Good results in 10 (50%) of patients in the JESS group and 08 (40%) patients in the ORIF group. 06 (30%) patients in the JESS group and 01 (5%) in the Plating group had fair anatomical results.

In this study, functional outcome considering range of motion was significantly better for the Plating group in comparison to the JESS group. Also the grip strength was significantly ($p=0.003$) better in the Plating group as compared to the JESS group. In the patients treated with JESS, the grip strength gradually improved after frame removal and after physiotherapy sessions and longer follow-up became comparable to the plating group.

Comparing the radiological parameters except for palmar tilt ($p=0.001$) we did not find statistically significant difference between the two groups. The therapy session required for the JESS group were significantly greater ($p< 0.05$) as compared to the plating group. We also found that the range of motion and grip strength improved in the JESS group at the end of 12 months of follow up period and was comparable to the plating group.

Considering the fracture pattern, in AO type B fracture pattern Plating showed better results (both anatomical and functional) as compared to JESS. In AO type C, the results were comparable between the two groups, with the JESS group having better anatomical results.

Kapoor H et al concluded that articular anatomy was best restored with open reduction internal fixation, although external fixator achieved a better functional outcome.¹⁰

Zamzuri et al in their short term study comparing external fixation versus internal fixation for closed unstable intra-

articular fractures of distal radius reported that the anatomical results were better in the internal fixation group compared to the external fixation group. The volar tilt, radial inclination and radial height were all well maintained. There were no differences in functional results between these two types of fixation at six months and one year. In external fixation group higher complication rate were present.¹⁴ Better result were found for internal fixation with AO plates either volarly or dorsally when compared to bridging external fixation with augmentation with kirschner wires at the surgeon's discretion according to recent study by Leung et al.¹⁵

Plating group to have better radiological and functional results in comparison to external fixation and the non-locking palmar plating methods according to N. Schmelzer et al. The subjective assessment of plate fixation proved to be better than that of external fixation. In both plate and fixation groups complications and reoperations were few.¹³ In study done by WeiDH et (2012) concluded that ORIF is significantly better forearm supination, restoration of anatomic volvar tilt and functional outcomes and external fixation result better in wrist flexion, better grip strength and remains a viable surgical alternative.¹⁶

CONCLUSION

In our study, we concluded that in the treatment of distal end of radius fractures, plating gives better functional results as compared to JESS fixator, and allows for early mobilisation of patients. The anatomical results are similar in both treatment group except for better restoration of palmar tilt with the plating group. The grip strength is better in the plating group as compared to JESS group. Closed reduction and JESS fixation gives good results in the treatment of intra-articular comminuted distal end of radius fractures (AO type C), comparable to ORIF with plating. Number of physiotherapy sessions required to regain the range of motion are more for the patients treated with JESS as compared to Plating group. Pin tract infections, reoperations are some of the complications associated with JESS fixation, which were not observed in the plating group.

Thus, with no need of implant removal, better grip strength after long term follow-up are some of the advantages of JESS fixation and remains a good treatment option for distal end radius fracture.

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