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Functional outcomes of jess fixator application in fractures of distal end radius: A prospective study

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Abstract

Fracture of distal end radius is one of the most common fractures encountered by an orthopaedician in casualty or OPD setting. These fractures show bimodal distribution. Insufficiency fractures (low velocity injuries) in osteoporotic bone elderly and following high velocity injuries in young population. Fracture of distal end radius is one of the commonest insufficiency fractures (Most common fracture due to fall on outstretched hand in adults) in elderly. Among all fractures of distal end of radius, about 50% of them involve the articular surface of - radiocarpal joint or distal radioulnar joint and considered as unstable. Because premature axial loading causes displacement of the fracture fragments and impairs the articular congruity attained by the reduction technique and this may lead to post traumatic osteoarthritis of the wrist and/or deformity.

Different modes of treatment are there including most commonly performed closed manual reduction of fracture of distal end radius and slab or cast application, closed reduction and internal fixation with Kirschner wires (percutaneous pinning or intrafocal pinning) with or without slab, volar or dorsal plating, external fixation and Joshi's external stabilization system (JESS) depending on the fracture geometry and fracture type

Collapse, loss of palmar tilt, radial shortening, and articular incongruity are frequent after closed treatment of unstable and comminuted intra-articular fractures of the distal radius, and these often result in permanent deformity, pain, and loss of function.

The use of transfixing K-wires with external fixation is recommended for severely comminuted fractures. Anderson and O Neil were first to maintain fracture reduction with an external fixator using principle of ligamentotaxis. JESS fixator application as compared to closed manual reduction and slab/cast application +/- k-wire is superior in terms of functional outcome and less complications like wrist and elbow stiffness that are more common in the latter.

Keywords: JESS fixator, distal end radius, intra articular fractures, treatment, functional outcome

Introduction

Fracture of distal end radius is one of the most common fractures encountered by an orthopaedician in casualty or OPD setting. Distal radius fractures are the commonest fractures in upper extremity [1-3].

Distal end of radius fractures show bimodal distribution, mostly insufficiency fractures (low velocity injuries) in osteoporotic bone of elderly and following high velocity injuries in young patients. Increasing incidence of these injuries may be attributed to an aged population and the growing participation in outdoor pursuits (higher energy fractures) [4-6].

With increase in longevity, there is proportionately increased percentage of osteoporotic people, especially females. Fracture of distal end radius is one of the commonest insufficiency fractures (Most common fracture due to fall on outstretched hand in adults) in elderly [7, 8] Osteoporosis associated with aging increases the risk of these fractures in elderly individuals and also increases the risk in women, who are more commonly affected by osteoporosis [9]. Ideally, a distal radius fracture in women older than 50 years of age should indicate a DEXA scan to assess bone quality [8].

In paediatrics, fractures often occur around the time of puberty due to low bone mineralization. Interestingly, ages 19 to 49 years make up the least common age group for these injuries [8].

Among all fractures of distal end of radius, about 50% of them involve the articular surface of either the radiocarpal joint or distal radioulnar joint and considered as unstable.

Because premature axial loading causes displacement of the fracture fragments and impairs the articular congruity attained by the reduction technique and this may lead to post traumatic osteoarthritis of the wrist and or deformity [10].

Hence the quality of reduction and fracture fixation technique are much more important for better outcome and patient satisfaction. Fernandez and Trumble reported that even as little as 1mm of articular incongruity will deprive the functional outcome [11].

Distal radius fractures have still remained a therapeutic challenge [12]. Treatment part remains debatable as many treatment modalities are available which are may vary according to different fracture patterns and morphology, different age group, availability of implants and infrastructure, socioeconomic constraints etc.

Different modes of treatment for fractures of distal end radius are there including most commonly performed closed manual reduction of fracture of distal end radius and slab or cast application, closed reduction and internal fixation with Kirschner wires (percutaneous pinning or intrafocal pinning) with or without slab / cast support, volar or dorsal plating, external fixation and Joshi's external stabilization system (JESS) depending on the fracture geometry and fracture type [13-15].

Collapse, loss of palmar tilt, radial shortening, and articular incongruity are frequent after closed treatment of unstable and comminuted intra-articular fractures of the distal radius, and these often result in permanent deformity, pain, and loss of function [14-17].

In compound and or comminuted intra articular fractures of distal end radius, anatomical reduction of the fracture fragments is the key to better outcome for good functional outcomes. Hence to maintain anatomical reduction, even closed reduction internal fixation with K wires alone will not be adequate in some cases.

In such cases, External fixator application (Ligamentotaxis principle) helps to keep all the fragments in place and thus better functional outcome than cast or k wire fixation.

The use of transfixing K-wires with external fixation is recommended for severely comminuted fractures. [14, 16] Anderson and O Neil were first to maintain fracture reduction with an external fixator using principle of ligamentotaxis.

In comminuted fractures plate application has been proven superior in functional outcome than K wire fixation or JESS fixator application in some studies. But in a developing country like India, often there are constraints of infrastructure, implant availability and in rural areas monetary constraints. Hence option of locking plate although proven superior in functional outcome cannot be always the answer and thus, we have to look towards options which are affordable and provide good functional outcomes which are comparable to plate application.

JESS application as compared to plate application - require less infrastructure, cheaper, less invasive and requires less surgical time.

JESS fixator application as compared to closed manual reduction and above elbow slab application / k wire application is superior in terms of functional outcome and less complications like wrist and elbow stiffness that are more common in the latter.

Materials and Methods

Study Place: Indira Gandhi Government General Hospital and Post Graduate Institute, Puducherry.

Study design: Prospective

Study duration: 1 year

Sample Size: 33

Single Proportion - Absolute Precision

Expected Proportion 0.822

Precision (%) 13

Desired confidence level (1-alpha) % 95

Required sample size 33

Table 1: Single Proportion — Absolute Precision

Expected Proportion	0.822
Precision (%)	13
Desired confidence level (1-alpha) %	95
Required sample size	33

Sample size was estimated by using nMaster software Version 2.0 by applying following details in the above formula. Based on the study by Rajeev Shukla *et al.* 67 (A total of 170 patients with intra-articular distal end radius fracture were treated with JESS from 2014 to 2017, in which. The good and/or excellent results were found in 82.2% of cases.).

Based on the above parameter with an alpha of 0.05 (2 sided) and precision level of 13%, the estimated sample size came to be 33 using the sample size formula for Single proportion.

Statistical tool details

The collected data was analysed with IBM.SPSS statistics software 23.0 Version. To describe about the data descriptive statistics frequency analysis, percentage analysis was used for categorical variables and for continuous variables the mean and S.D was used. To find the association of significance in categorical data the Chi-Square test, Fisher's exact test, one-way Anova test, paired/ unpaired students T test was used. In all the above statistical tools the probability value .05 was considered as significant level.

Inclusion Criteria's

1. age 18-75 years
2. Frykman type 3 TO 8 fractures
3. Open or closed injury
4. Less than 2 weeks old injury
5. Patient willing for surgery

Exclusion Criteria's

1. Age less than 18 or more than 75
2. Frykman type 1 and 2 fractures.
3. Pathological fracture
4. Concomitant fracture of other bone in wrist /hand /forearm.
5. More than 2 weeks old injury/Fractures with non-union
6. Neurovascular condition involving ipsilateral upper limb
7. Neurovascular complication following trauma
8. Patient unwilling for surgery
9. Depression of articular surface

Surgical Procedure

All surgical procedures were done under General anaesthesia / Regional anaesthesia depending on the anaesthetist preference. Patients were placed supine on operation table. Hand table was used in all cases. In all cases, pneumatic tourniquet was applied over arm. Forearm and hand were

scrubbed with savlon, betadine and saline. Painting of forearm and hand with betadine was done. Draping was done. Forearm to be operated was placed on radiolucent arm board. Closed reduction was done under c arm guidance. A specialist from orthopaedics department performed the surgeries. In all cases 0.5 cm incision for two 2.5 mm Schanz pins each distal to fracture line was made and 0.5 cm incision each for two 3.5mm Schanz pin in distal part of radius. After application and distraction of JESS distractor was fixed in position over schanz pins with help of Allen key. Betadine gauze dressing was done for pin tract. Cuff and collar was given to maintain limb in position and patients were shifted to Post operative ward. Post operative X ray was taken on post operative Day 1 and patient was encouraged to do finger range of motion exercises from post operative day 1. Dressing was done on post operative day 2. Patient was discharged from ward on post operative day 3 or 4. Patients were asked to follow up weekly once in O.P.D. for first 2 weeks for pin tract dressing and physiotherapy. Thereafter once in two weeks for dressing and physiotherapy. Serial X rays of operated limb were taken as per following schedule on postoperative - Day 1, 2nd week, 6th week, 3rd month, 6th month.

Result

- Total 33 patients were included in study
- Out of which 27 were male and 6 were female
- K wire used in 5 patients
- Left sided distal end of radius fracture in 15 patients
- Right sided distal end of radius fracture in 18 patients
- As per Frykman’s classification, maximum number of patients, 9 belong to Frykman type 3, Minimum number of patients 0 belonged to type 7.

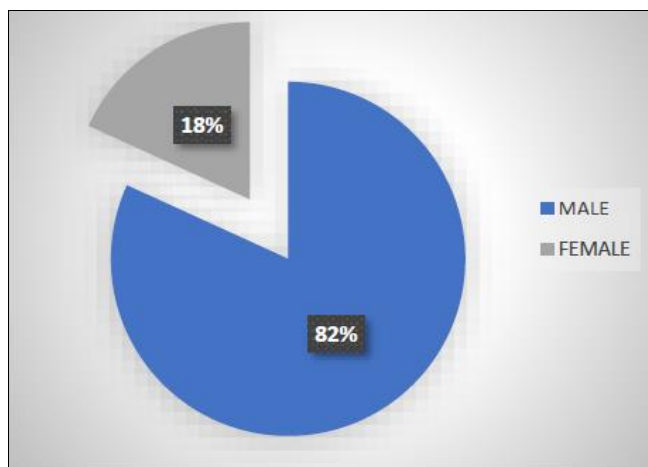


Fig 1: Patient gender

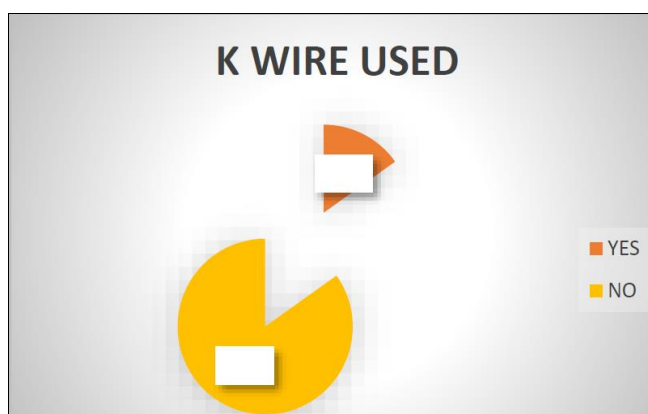


Fig 2: No. of patient with and without k-wire

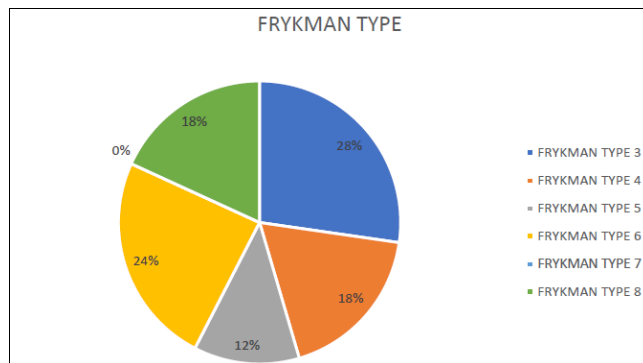


Fig 3: Classification of fracture

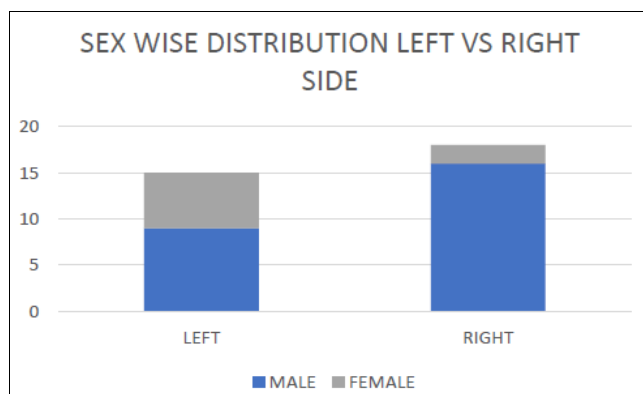


Fig 4: Sex distribution of patients

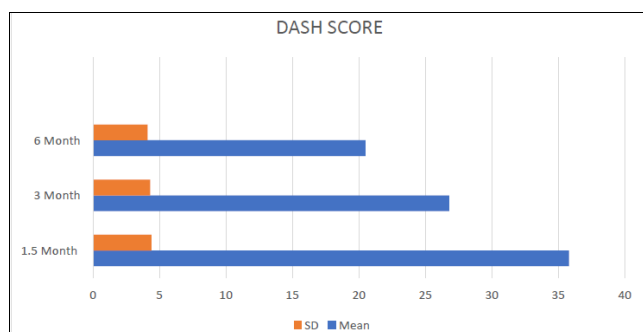


Fig 5: Visual representation of DASH score with Mean and S.D.

Discussions

The successful use of external fixation requires careful assessment of fracture pattern, correct surgical techniques, supplemental fixation with K-wires, adherence to a postoperative protocol involving pin tract care, and early mobilization. [17]. Many external fixation devices are described to achieve reduction and fixation of the fragments without loss of position and acceptable functional results [18]. In our study, JESS fixator was used for treatment of undisplaced and displaced intraarticular distal end radius fractures which allowed sound fracture union with functional mobility With excellent and good results in 81.8% patients’ fair results in 12.12% patients and 0% poor results in Modified mayo score. On Comparison with Shukla *et al.* [17].

Table 1: Complications

	Shukla <i>et al.</i>	Current study
Pin tract infection	12	0
Subchondral bone loss (2 week)	4	3
Delayed union	4	1
Articular collapse after removal of JESS fixator	9	0
C.R.P.S.	4	0

Early postoperative period improvement in Mayo scores (up to 3 months) was statistically significant in age group less than 50.

On Final follow-up we found no statistically significant difference in Modified Mayo scoring between less than 50 years and more than 50 years age group.

There was no statistically significant difference in final follow-up scores between males and females.

Table 2: Assessing functional outcome using Modified Mayo Score

	Modified mayo score for measuring functional outcome
2017 - Muharrem Kanar et al.	37.9%) were excellent, (41.3%) good, (17.2%) were fair, (3.44%) was bad
Slmicla et al. (2019)	Excellent and good results in 82.2 % patients
CtuTent study (2022)	Excellent and good results in 81.81 % patients

In current study, there was no statistically significant difference in DASH scoring with respect to

- Age = no statistically significant difference in <50 year and >50-year age group found
- Sex = No statistically significant difference found between male and female patients
- Side = right / left
- Postoperative time (1.5 month/3 months/6 months)

Table 3: Dash Score

Study	Dash scores
Pradhan et al.	DASH at 3 months= 50.89±25.93 DASH at 6 months= 13.79±10.46
Mahajan et al [13]	DASH scores (Mean + S.D.) DASH at 1 month = 76.08 ± 6.16 DASH at 3 months= 62.92 ± 4.50 DASH at 6 months= 42.60 ± 1.65
Current study (2022)	DASH scores (Mean + S.D.) DASH at 1.5 month = 35.8 ±4.4 DASH at 3 months= 26.8 ± 4.3 DASH at 6 months= 20.5±4.1

In current study, in 2 patients, there was inadequate callus formation at the end of 6 weeks of postoperative period. For them JESS fixator was kept in situ additionally for 2 weeks (Total 8 weeks) At end of 8 postoperative weeks in total, repeat x ray was taken. Satisfactory callus was found on x ray in AP and lateral views and after which JESS fixator removed after that. In 3 patients, there was loss of subchondral height, observed at 2 weeks of post operative period. For them, redistraction was done on OPD basis immediately. Check x ray was taken to ensure adequate distraction was achieved. On subsequent follow-up no further collapse was observed. 1 Patient suffered from neurapraxia of superficial branch of radial nerve, which was treated conservatively. Symptoms resolved by end of 6 th week postoperative. No lasting sensory loss seen. As a policy, regular dressing was done in ward while patients were admitted and patients were advised to do regular pin tract dressings post discharge. No cases of pin tract infection were observed in study time. In current study after removal of JESS fixator, no patient had articular collapse. In current study 0 patients developed chronic regional pain syndrome.

Table 4: Complications

	Complications
Shukla et al. (2019)	Delayed Union (> 6 weeks) = N/A Loss of subchondral height = 4 patients at 2 weeks Pin tract infection = 12 patients. Which was managed successfully by antibiotic treatment. Articular collapse was seen after the removal of JESS=9 patients Complex regional pain syndrome = 4 patients, which was managed successfully by conservative management.
Michael G, George K, Canjirathinkal M A, et al.	Delayed Union (> 6 weeks) = N/A Loss of subchondral height = N/A Pin tract infection patients Articular collapse
Current Study (2022)	Delayed Union (> 6 weeks) = 2 patients Loss of subchondral height = 3 patients at 2 weeks Pin tract infection patients Articular collapse = 0 patients Neurapraxia (Damage to superficial branch of radial nerve) = 1 patient

Clinical images



Fig 6: Clinical images

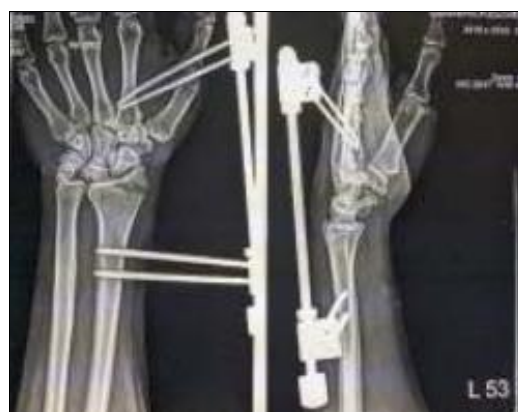


Fig 7: Post operative 6 week follow up xray



Fig 8: Post operative 6 month follow up X-ray

Conclusions

Functional outcome was better in age group less than 50 years on 3 months follow up. Early postoperative period improvement in Mayo scores (up to 3 months) was statistically significant in age group less than 50. On Final follow up we found no statistically significant difference in Modified Mayo score scoring between less than 50 years and more than 50 years age group. There was no difference in functional outcome gender wise (that is statistically significant difference in final follow-up scores between males and females). There was no statistically significant difference in functional outcomes with respect to side (between left and right side).

In a developing country like India, often there are constraints of infrastructure, implant availability and monetary constraints. Even though the option of locking plate has been proven superior in functional outcome it cannot be always done practically. Hence options which are affordable and provide good functional outcomes which are comparable to plate application are required.

JESS application as compared to plate application - require less infrastructure, Cheaper, and requiring less surgical time and avoiding the re-surgery. JESS fixator removal can be done in under local anaesthesia without subjecting patient again to either general anaesthesia or regional anaesthesia. Plating for fracture of distal end radius has complications such as Carpal tunnel syndrome, Nerve dysfunction, tendon injury (Tendon rupture), Complex regional pain syndrome, Implant removal by patient request. For plating cases, implant removal after complete bony union (1.5 - 2 years later) which usually is done under regional or general anaesthesia, again entails all the risks of original surgical procedures plus risk of inability to remove the implant. Risk of causing iatrogenic fracture to bone and thus subsequent re application of hardware. Thus, JESS fixator is recommended for treatment of intra articular fractures of distal end radius.

Conflict of Interest

Not available

Financial Support

Not available

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