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ORIGINAL ARTICLE

TREATMENT OF INTRA-ARTICULAR DISTAL RADIUS FRACTURES BY A COMBINED DYNAMIC AND STATIC JESS MINI EXTERNAL FIXATION TECHNIQUE

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ABSTRACT: OBJECTIVES: The present study is conducted to evaluate the fracture healing and functional results of combined dynamic with static external fixator for comminuted distal radius fracture. Material and methods: Twenty three adult patients with twenty six comminuted distal radius fractures between age group of 21-67yrs were included. There were five Fry kman type 6, ten Frykman type 7 and eight Frykman type 8 fractures. Closed reduction with ligamentotaxis and percutaneous k-wire fixation was done. Wrist spanning mini external fixator was applied and the k-wires supporting the intra-articular reduction were incorporated into the fixator. The fixator was dynamized at 3 weeks by removing the metacarpal pins and cutting short the connecting rod. The dynamized frame was maintained for 3-6weeks. The patients were followed up for 1 year. Gartland and Werley scoring system was used to assess functional outcome. **RESULTS:** Average time to union was 7.4 weeks. 11 patients (48%) were rated as excellent, 9 (40%) rated as good and 3 (12%) as fair under Gartland and Werley score. **CONCLUSION**: Our technique of modified JESS fixator did demonstrate good anatomical restoration and early objective functional results.
KEYWORDS: Radius, intra-articular, jess, external fixator, dynamic, static.

INTRODUCTION: Since their description by Colles in 1814, distal radial fractures remain a therapeutic challenge.[1] Very commonly, collapse, loss of palmar tilt, radial shortening, and articular incongruity are seen after closed treatment of unstable and comminuted intra-articular fractures of the distal radius. These often result in permanent deformity, pain, and loss of function. Because of their propensity to go for loss of reduction in closed reduction and plaster cast application, skeletal fixation is often recommended to maintain the reduction.

K- wire fixation is the commonest modality chosen. Frequently, incorporation of transfixing Kirschner wires (K-wires) within the plaster is done to augment stabilization with plaster. Furthermore, use of external fixation is recommended for severely comminuted fractures as they provide a valuable alternative to and often better outcomes than internal fixation with mini-plates.[2]

Many external fixation devices are described[3] to achieve reduction and fixation of the fragments without loss of position and acceptable functional results. Ligamentotaxis is the basic principle used in external fixation. This helps in freeing the impacted fragments and allowing further reduction by joysticking the main fragments. Frequently, this distractor has to be left in-situ in the form of a wrist spanning external fixator till fracture healing as the small fragments are seldom held robustly by those small k-wires.

This prolonged rigid immobilization of the wrist in an external fixator leads to periarticular fibrosis and resultant stiffness is inevitable. This leads to compromised functional outcome. Often,

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intense physiotherapy is required to rehabilitate these patients. The early mobilization of the wrist helps in normalization of blood supply and nutrition of the injured cartilage. This helps in resolution of local swelling, prevents wrist stiffness and hastens functional recovery.

Non-spanning external fixators have the theoretical advantage of allowing wrist mobilization early with the attendant advantages, [4] but often the fixation of pins in small comminuted distal fragments is unsatisfactory. The dynamic external fixators have been developed to provide spanning fixation and at the same time allowing mobilization of the wrist while reduction and fixation are maintained. One such fixator which is popular in Western world is the Penning fixator.[5] The device allows wrist flexion by a hinge joint, with the center of motion being at the capito-lunate joint. Such devices are costly and not universally available.

Wrist sparing external fixators have been described[4, 6, 7] which have been shown to allow better restoration of anatomy in terms of radial length, radial tilt and inclination. These fixators again are costly and not easily available. Instead, we have devised a modification of the standard monoplanar static joint spanning external fixator (Joshi's external stabilizing system) along with incorporation of the transfixing k wires of the distal fragments into the same JESS frame. This provides us with robust static joint spanning fixator for initial 3 weeks.

After that time, the fixator is made into a dynamic one by removing distal metacarpal pins and cutting short the connecting rod as needed. Then, aggressive mobilization is allowed. This modification allows reliable support against axial deforming force in the initial phase followed by wrist mobilization as the fracture starts to consolidate. We report the evaluation and results of this modified external fixation system.

MATERIAL AND METHODS: This study was carried out at the Department of Orthopedics, Sri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India. Approval from the Ethics Committee of our hospital was taken. Patients were included in the study if they had a displaced unstable comminuted fracture of the distal radius. This was defined as any distal radial fracture with more than 20° of dorsal angulation, metaphyseal comminution with or without intra-articular extension and more than 2 mm of positive ulnar variance. Exclusion criteria were 1) An open fracture 2) A pathological fracture 3) Fractures needing open reduction 4) Ipsilateral upper limb fracture 5) Injury or preexisting arthritis which was likely to impact rehabilitation.

Operative Procedure: All surgeries were performed under regional anesthesia. In all cases, closed reduction was performed. After manipulation and traction adequate reduction of comminuted fragments was obtained under c-arm control. Then 3 percutaneous K-wires were used to fix the fracture fragments. First wire was from the radial styloid fixing it with the opposite proximal cortex. Second wire from dorsal side near Lister's tubercle into the proximal volar cortex.

Third wire was passed from the distal ulna transfixing the distal radial articular block. Joint spanning monoplanar JESS frame was applied with 2 Schanz screws in shaft of radius and 2 Schanz pins in 2nd metacarpal shaft at 60 degrees to the coronal plane. Wrist was kept in slight ulnar deviation of about 15 degrees and fixed in traction. Then, as many as possible (at least two) k-wires were incorporated into the JESS fixator in between the two main anchoring posts (metacarpal and radius). Satisfactory reduction was confirmed under the image intensifier.

After surgery, finger and elbow movements were started in the immediate postoperative

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period and gradually increased as tolerated. Usually, the patients were able to achieve full IP joint movements and more than 50% grip strength of the contralateral side by 3 weeks. Then, the wrist was dynamized by removing the metacarpal pins usually as an out-patient procedure under local anesthesia, allowing range of motion exercises (except prono-supination) at wrist. After 6 weeks, the radio-ulnar transfixing wire was removed and for two more weeks, supination and pronation was allowed.

Aggressive mobilization of the wrist was encouraged after final removal of fixator and k-wires at 8 weeks post-surgery. The rehabilitation program was continued for 6 to 8 weeks after removal of the fixator supported by wrist splint as needed. Local complications like pin track infection and reflex sympathetic dystrophy (RSD) were recorded.

Residual deformity	
Prominent ulnar styloid	1
Residual dorsal tilt	2
Radial deviation of hand	2-3
Point range	0-3
Subjective evaluation	
Excellent	
No pain, disability or limitation of motion	0
Good	
Occasional pain, slight limitation of motion, no disability	2
Fair	
Occasional pain, some limitation of motion, feeling of weakness in wrist, no particular disability if careful, activities slightly restricted	4
Poor	
Pain, limitation of motion, disability, activities more or less markedly restricted	6
Objective evaluation*	
Loss of dorsiflexion	5
Loss of ulnar deviation	3
Loss of supination	2
Loss of palmarflexion	1
Loss of radial deviation	1
Loss of circumduction	1
Loss of pronation	2
Pain in DRUJ	1
Grip strength – 60% or less of opposite side (using dynamometer)	1
Point range	0-5
End result point ranges	
Excellent	0-2
Good	3-8
Fair	9-20
Poor	21 and above

*Objective evaluation is based on the following ROM is being minimum for normal function, Dorsiflexion - 45°, Palmarflexion - 30°, Radial deviation - 15°, Ulnar deviation - 15°, Pronation - 50°, Supination - 50°, DRUJ - Distal radio ulnar joint

Figure 1: Modified Gartland and Werley scoring system

The functional outcome was assessed using Gartland and Werley[8, 9] score recorded at 3 months, 6 months, and 1 year. At each follow-up, radiography was repeated. A record was kept of the volar tilt of the distal radial fragment, the loss of ulnar tilt of the distal radius, and loss of radial height (as compared to the uninjured side).

RESULTS: 23 patients with the same number of fractures were included. The follow-up rate was 91% (21 cases). The mean age of patients treated with our modified JESS fixator was 35.9 years (range =

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21 to 67 years). The patients were predominantly males (n = 14, 61%). Most of the patients were manual laborers engaged in farming. The dominant hand was injured in 15 patients (65%) patients. Falls was the predominant (>80%) mode of injury. There were five Frykman type 6, ten Frykman type 7 and eight Frykman type 8 fractures. The mean delay between the time of injury and surgery was 3.5 days (range: 1–7 days).

The average operative time was 48 minutes (range: 25–85 minutes). In 3 cases, fracture site manipulation and application of a plaster splint had been tried elsewhere initially with unsatisfactory results. Seven patients (31%) had a clinically superficial pin-site infection after initial fixation and 3 cases were found to have superficial infection after dynamization. These were treated with oral antibiotics. No deep infections were seen, and no pins were removed because of infection. No cases of fracture collapse necessitating reoperation were seen during the early follow up period. Average time to union was 7.4 weeks (5 -11 weeks.)

One year after the treatment, reduced supination with positive ulnar variance of 2mm was seen in two patients (8%); only one had ulnar sided pain and was offered surgical ulnar shortening which she refused. No case of rupture of the extensor pollicus longus tendon was observed during the follow up period. No other complications such as carpal tunnel syndrome or reflex sympathetic dystrophy were noted.

Using the modified Gartland and Werley score, 11 patients (48%) were rated as excellent, 9 (40%) rated as good and 3 (12%) as fair. None was rated as poor. The mean VAS score was 0.7 (range 0–3) only 4 patients (17%) scored more than 1. On radiological examination, we found no significant difference in radial length, angulation or inclination, when the differences between the postoperative, 5-week and 12-month follow-ups.

DISCUSSION: Dynamic external fixation was first introduced by Clyburn in 1987[10]. He proposed to reduce the final disability associated with an unstable fracture of the distal radius by facilitating early motion of the wrist. Similar results were obtained by Penning and coworkers using their design of a dynamic fixator[5]. Klein et al.[11] in their small study showed that dynamization of the wrist at 3 weeks may lead to improved function.

Other studies have also found good to excellent results with an external fixator allowing wrist mobility (Hayes et al,[6] Hove et al,[4] Gradl et al.[7]) Non-bridging external fixation was found to offer a reliable method of maintaining radiological reduction of unstable distal radius and to give a good functional outcome after 1 year by Anderson et al.[12]

Our study revealed significant advantage in terms of anatomical restoration and early functional outcome of early dynamization using the modified JESS fixator for displaced unstable comminuted fractures of the distal radius. The JESS fixator consistently restored the palmar tilt of the distal radius, and loss of ulnar tilt and radial height was acceptable. There was no loss of achieved anatomical correction over 1 year of follow-up needing surgical correction. There were no cases of nerve injury in our study while 4 cases of nerve injury were found by Krukhaug et al[13] in their study of dynamic fixation in 75 patients.

Early wrist movements by dynamizing the fixator did not lead to accelerated loss of reduction which is in contradiction to the results of Atroshi et al[14] who found that for moderately or severely displaced distal radius fractures in the elderly, non-bridging external fixation had no clinically relevant advantage over wrist-bridging fixation. But they added that a non-bridging external fixator

was more effective in maintaining radial length. Restoration of anatomy may lead to improved restoration of objective measurement of joint movement and function but it has little effect on subjective functional outcome. Our results are also different from those of Krishnan et al[15], who too found no demonstrable statistically significant difference in the radiological and clinical outcomes achieved with either wrist bridging and non-bridging external fixation systems.

The k-wires in the distal fragment permit the surgeon to have direct control, which allows exact repositioning. Our modified method of JESS fixation incorporating those k-wires of the distal radius fracture fragment into the JESS fixator and then subsequent removal of the metacarpal pins early provided reliable strong resistance against deforming axial forces till the articular block started to congeal when the fixator was dynamized by simple removal of distal metacarpal pins alone. This is a simple cheap design for converting a wrist spanning fixator to a wrist sparing fixator during the early period of fracture healing. This permits stability when needed the most followed by allowing mobility in a controlled stable environment later on.

Our study has a few limitations. Most of our patients were active males below 60 years of age and had good bone stock. Hence it may not be possible to extrapolate our results to an older age-group or postmenopausal female patients with poor bone quality. The major strength of our study is the 100% follow-up rate.

Over last decade there have been numerous clinical trials that have tried to find the best method of management for displaced unstable comminuted distal radial fractures. Various Cochrane reviews[16-18] of the subject concluded that there is still no robust evidence to support any specific modality of treatment over another. Another recent systematic review from Medline database[19] has concluded that non-bridging fixation may result in better functional and radiological results than static wrist-bridging fixation when considering patients of all ages with earlier return of function.

CONCLUSION: Our technique of modified JESS fixator did demonstrate good anatomical restoration and early objective functional results. Larger clinical trials are needed to confirm the utility of this external fixator design in the subgroup of unstable distal radius fractures.

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Intraoperative status and post operative x-ray showing good reduction

Post-operative status: wrist spanning fixator in-situ

Fixator converted into wrist sparing frame

Palmar and dorsi-flexion started after dynamization

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Dorsi-flexion and Palmar flexion at 1 year post surgery


Prono-supination at 1 year post surgery

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