



E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2022; 8(2): 258-263
© 2022 IJOS
www.orthopaper.com
Received: 24-01-2022
Accepted: 25-02-2022

Dr. Arun KN
Professor and Head, Dept of
Orthopaedics, Navodaya Medical
College Hospital and Research
Center, Raichur, Karnataka,
India

Dr. Guru Dixit S
PG Scholar, Department of
Orthopaedics, Navodaya Medical
College Hospital and Research
Center, Raichur, Karnataka,
India

Corresponding Author:
Dr. Guru Dixit S
PG Scholar, Department of
Orthopaedics, Navodaya Medical
College Hospital and Research
Center, Raichur, Karnataka,
India

Neglected paediatric distal radius metaphyseal fractures treated with Joshi's external stabilization system

Dr. Arun KN and Dr. Guru Dixit S

DOI: <https://doi.org/10.22271/ortho.2022.v8.i2d.3146>

Abstract

Purpose: Malunited distal radius fractures treated with internal fixation devices put the physis at risk of iatrogenic injury, while conservative treatment with a cast usually leads to loss of reduction. While the AO external fixator can be used, the radial inclination cannot be controlled during reduction. The purpose of this study was to ascertain the anatomical and functional outcome of treating malunited distal end radius fractures with Joshi's External Stabilisation system applied as a bilateral uniplanar construct in the paediatric age group.

Methods: Open reduction and external fixation with Joshi's External Stabilisation System were performed for 4 malunited distal metaphyseal fractures of patients below 16 years. Dorsal open wedge osteotomy with bone graft was performed at the fracture site and two k-wires were passed through both cortices proximal and distal to the site of fracture and reduction was achieved with two distraction rods placed radial and ulnar to the radius bone. The external fixator was removed after the union, and the wrist was mobilised. The patients were followed up till full ROM was achieved. Anatomical outcome analysis was done using Sarmiento's modification of Lindstrom criteria, and functional outcome analysis was done using Gartland and Werley demerit point system.

Results: In our study, 4 patients underwent open reduction and external fixation using Joshi's External Stabilisation System and all showed fracture union with no complications. The mean age of the patient was 12.25 years (Range-11-14). Meantime to osteotomy after injury was 10.25 weeks (Range-4-22). Mean QuickDASH score improved significantly from 6.25 preoperatively to 1.25 postoperatively ($p=0.003$). Mean Radial inclination improved significantly from 6.25 to 18 ($p=0.009$). Ulnar variance improved significantly from 1.75 to 0.25 ($p=0.01$). Palmar tilt improved significantly from 32.5 to 6.25 ($p=0.001$).

Conclusion: Our study shows good results with fixation using Joshi's External Stabilisation System for malunited paediatric distal metaphyseal fractures.

Keywords: Joshi's external stabilisation system, malunion, neglected, paediatric, corrective osteotomy, distal radius fracture

Introduction

Fractures of the distal forearm are quite common in children and are usually greenstick injuries. Displaced injuries, although uncommon, are treated promptly as they have obvious deformity and parents want to get it corrected right away. Rarely, displaced fractures are left untreated and end up in malunion. The usual mode of treatment in such cases is drill osteoclasis with internal fixation. Owing to the proximity of the fixation device to the physis, the chances of iatrogenic injury to the physis is high which may lead to growth arrest. Our study aims to use the JESS fixator with hardware placed away from the physis to avoid the injury altogether. Malunited fractures of distal third of forearm usually remodel in children less than 11-12 years of age, and the distal radius fuses by about 18 years of age^[1,2].

Materials and Methods

Ethics: Ethical committee clearance taken from ethical committee of our institute and informed consent taken from parents/guardians of the patient.

Type of Study: Observational Cohort Study

Source of data: The study is conducted in 4 patients in the Department of Orthopedics of our Institution

Method of collection of data

Inclusion criteria

Patients with

1. Malunited distal metaphyseal fracture of radius
2. Age below 16 years
3. Loss of range of motion
4. Pain

Exclusion criteria

1. Patients with
 - a. Physeal injuries
 - b. intra articular extension
 - c. Congenital developmental defects
2. Patients not willing/ unfit for surgery.

Materials: Mentioned below are the materials utilized

Instruments

1. Appropriately sized k-wires
2. JESS double pin distraction rods
3. Knurled rods
4. Clamps
5. Appropriate osteotomes, powered drill

Pre-medication

A stat dose of Inj. Cefotaxime according to weight

Operative details

a) Position of the patient

Patient is in supine position on fluoroscopic table with arm supported on a side arm board.

b) Procedure in detail

Under General anesthesia, the radius is approached via the posterior approach, and the dorsal open wedge osteotomy is performed with osteotome (Fig 3). Two k-wires are passed through and through proximally through the radius from radial and volar to ulnar and dorsal and two more k wires passed distally through the 2nd and 3rd metacarpals from radial to ulnar, such that two double pin distracting rods can be placed both ulnar and radial to the radius bone. While inserting the proximal k wire, due to the proximity of the Posterior Interosseous nerve and vessels to the trajectory of the k-wire, the incision is extended proximally to visualize and protect the same by retracting the bundle with a wet gauze piece. Leaving enough place for access for dressing, clamps are used to connect 4 knurled connecting rods two proximally and two distally, 1 on either side of the radius, to add stability to the construct and prevent bending of k wires during distraction (Fig 4). The distraction is performed, and correction of radial height, radial inclination and palmar tilt is checked on fluoroscopy. The ulnar distraction rod aids in achieving the appropriate radial inclination of the distal radius. Bone graft, harvested from iliac crest is placed in defect. Wound is closed in layers.

c) Post-op Protocol

The patients were followed up every month after the surgery for radiographs to evaluate union and functional evaluation. External fixator was removed 4-6 weeks after the procedure and wrist mobilized. Further follow up for functional status was done till full wrist ROM was achieved. Physiotherapy for wrist ROM was continued till full ROM was attained.

d) Functional and Radiographic evaluation

Wrist movements were measured with a goniometer and the grip strength was measured with a Baseline Camry digital hand dynamometer (Fabrication Enterprises Inc., NY, USA). Functional outcome was analyzed with Demerit point system of Gartland and Werley (Table 2) [7], and patients were also given the QuickDASH [13] questionnaire. Standard posteroanterior and lateral radiographs of the wrist joint were taken, and anatomical outcome assessed with Sarmiento's modification of Lindstrom's criteria (Table 1) [8].

e) Statistical Method

General descriptive statistics were used to represent age, gender, time to osteotomy and duration of follow up as mean. The difference in range of motion, grip strength, radiological parameters was analyzed using Student's paired t- test. Values of $p < 0.05$ were considered significant

Results

In our study 4 patients underwent open reduction and external fixation using Joshi's External Stabilisation System and all showed fracture union with no complications. Mean age of the patient was 12.25 years (Range- 11-14). Mean time to osteotomy after injury was 10.25 weeks (Range- 4-22). Mean duration of follow up was 21.5 weeks (Range- 18-26). Mean grip strength at follow up was 94.3% of opposite hand (Range- 87.8-100). The mean demerit point system of Gartland and Werley score was 7.5 preoperatively and improved significantly to 0.5 ($p=0.010$) postoperatively. Mean QuickDASH score improved significantly from 6.25 preoperatively to 1.25 postoperatively ($p=0.003$). Mean Radial inclination improved significantly from 6.25 to 18 ($p=0.009$). Ulnar variance improved significantly from 1.75 to 0.25 ($p=0.01$). Palmar tilt improved significantly from 32.5 to 6.25 ($p=0.001$). None of the patients had any residual deformity.

Discussion

All patients in this series were older than 11 years. In adolescents, distal metaphyseal radius is at risk of fractures because of dissociation of bone growth and mineralization during this phase [10, 11]. When these injuries are left untreated or inadequately treated, they undergo malunion. there are three possibilities after this in the immature forearm- increase in deformity, persistence of deformity and spontaneous recovery. an increase in deformity is seen physeal injuries and is a clear-cut indication for surgery [3]. Spontaneous recovery, however, is limited by patient age and gender. It is due to this reason that angular deformities are considered for surgical correction when the expected growth remaining is not adequate for satisfactory remodeling. If such malunited fractures are left untreated, it may lead to development of other secondary morphological changes of the distal radio ulnar joint, which can affect the daily activities owing to restricted forearm rotation [12].

The common mode of treatment for malunited distal radius fractures that are less than fifteen days old is closed reduction, and in injuries with mature callus that prevents adequate reduction is open osteotomy [4, 5]. Indications for corrective osteotomy of the distal radius in patients with malunited fractures include functional loss of motion, pain and/or instability of the distal radioulnar joint and unacceptable cosmetic appearance of the forearm [5]. Larsen *et al.* report that malunion exceeding 18° in children older than 11 cannot be corrected spontaneously [9].

Various implants like k-wire, TENS nail, Plates, AO external fixator, JESS fixator, Ring external fixator can be used for fixation of distal radius fractures. However, external fixators ease the reduction with the use of distractors and correction of radial height. Unilateral external fixators like the AO external fixators, can achieve distraction of the fracture site, but fail in correcting the radial inclination. This is where the bilateral external fixator like the JESS is useful as radial height as well as radial inclination can be controlled in bilateral uniplanar external fixator constructs. External fixator assisted plating has the same advantage but owing to the proximity of the implant to the growth plate, there is an inherent risk for iatrogenic injury to the growth plate. Another option is the ring fixator, but the bulkiness and added cost of treatment were reasons why we chose not to use it.

Lastly, inserting k wires through the radius puts the posterior interosseous nerve and accompanying vessels at risk of injury

in the posterior aspect, which can be circumvented by performing the task under direct vision by extending the exposure proximally. The entry point being volar, the radial artery can be protected by pushing the radial artery medially.

The QuickDASH is a valid instrument for older children and adolescents older with upper extremity pathology. However, this questionnaire was used in a similar study and the authors are of the opinion that it is the next best available system measuring functional outcomes in a pediatric population¹⁴. This study has a few other limitations. Our study did not use sophisticated investigations like CT scans with 3-D reconstruction for evaluating the deformity and correction. We used simple X ray templating for the same. The sample size in our study is also quite small, hence further studies are needed utilizing CT scans for accurate assessment of the deformities and compare results of correction with different modes of fixation with a larger sample size.

Table 1: Sarmiento's Modification of Lindstrom Criteria

	Residual Deformity	Loss of Palmar Tilt (deg)	Radial Shortening (mm)	Loss of Radial Deviation (deg)
Excellent	No/Insignificant	0	<3	5
Good	Slight	1-10	3-6	5-9
Fair	Moderate	11-14	7-11	10-14
Poor	Severe	>14	>11	>14

Table 2: Demerit point system of Gartland and Werley with Sarmiento *et al.* modification for functional evaluation

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 palmar flexion	1
	Loss of radial deviation	1
	Loss of circumduction	1
	Loss of pronation	2
	Pain in DRUJ	1
	Grip strength- 60% or less of the opposite hand	1
	Point range	0-5
End result point ranges	Excellent	0-2
	Good	3-8
	Fair	9-20
	Poor	>21

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

Table 3 Data of surgical correction of deformities of the distal radius

Case	Sex	Age	Pre-treatment	Time to JESS removal (weeks)	Time from injury to osteotomy (weeks)	Length of Follow-up (weeks)	Extension/Flexion at follow up (deg)	Ulnar/Radial deviation at follow up (deg)	Pronation/Supination at follow up (deg)	Grip Strength at follow up (% of sound hand)	Functional Score (demerit point system of Gartland and Werley)	QuickDASH score	Loss of Palmar tilt at osteotomy (deg)	Loss of Palmar tilt at follow up (deg)	Ulnar variance at osteotomy (mm)	Ulnar variance at follow up (mm)	Radial inclination at osteotomy (deg)	Radial inclination at follow up (deg)	Residual Deformity	Modified Lindstrom Criteria score
1	M	12	Native splint	4	4	18	80-0-80	30-0-20	80-0-90	100	0	0	30	0	0	-1	5	20	None	Excellent
2	M	11	Neglected	4	9	24	70-0-60	30-0-25	80-0-85	96.7	0	0	35	10	+2	0	10	17	None	Good
3	F	12	Neglected	4	6	18	80-0-80	30-0-20	80-0-90	92.7	0	0	25	5	+2	+1	5	20	None	Good
4	M	14	Native splint	6	22	26	70-0-60	20-0-20	70-0-80	87.8	2	5	40	10	+3	+1	5	15	Slight	Good

Table 4: Data of preoperative range of motion

Case	Extension/Flexion (deg)	Ulnar/ Radial deviation (deg)	Pronation/Supination (deg)	Grip Strength (% of sound hand)	Functional Score*	QuickDASH Score
1	50-0-30	15-0-25	80-0-80	100	6	5
2	40-0-30	10-0-30	80-0-90	92.3	9	7
3	55-0-30	10-0-20	70-0-90	100	4	5
4	30-0-20	10-0-30	70-0-70	73.3	11	9

*Demerit Point system of Gartland and Werley

Table 5: Functional outcome

Parameter	Preoperative score (mean)	SD	Postoperative score (mean)	SD	p-value
QuickDASH score	6.5	1.9	1.25	2.5	0.003
Dorsiflexion	43.8	11.1	75	5.8	0.002
Palmarflexion	27.5	5	70	11.5	0.003
Ulnar deviation	11.25	2.5	27.5	5	0.006
Radial deviation	26.25	4.8	21.25	2.5	0.091
Pronation	75	5.8	77.5	5	0.391
Supination	82.5	9.6	86.25	4.7	0.391
Grip strength	91.4	12.6	94.3	5.3	0.569

Values in bold are significant (p<0.05)

Table 6: Anatomical outcome

Parameter	Preoperative (mean)	SD	Postoperative (mean)	SD	p-value
Radial inclination	6.25	4.8	18	2.4	0.009
Ulnar variance	1.75	1.2	0.25	0.9	0.01
Loss of Palmar tilt	32.5	6.4	6.25	4.8	0.001

Values in bold are significant (p<0.05)



Fig 1: Preoperative x-ray



Fig 2: Dinner fork deformity of right wrist



Fig 3: Dorsal open wedge osteotomy



Fig 4: Final construct



Fig 5: Postoperative Xray



Fig 6: Final Xray, 4 weeks post op

Conclusion

Our study shows that appropriate patient selection and good technique with the use of bilateral uniplanar JESS construct with distractors helps to achieve good correction with reduced risk of damaging the physis. JESS also has the added benefit of being cheaper than other similar external fixators. Mobilisation after removal of external fixator resulted in good ROM of the wrist and did not result in loss of reduction at the fracture site.

References

- Prommersberger KJ, Lanz U. Fehlverheilte Frakturen des Unterarmes im Wachstumsalter unter besonderer Berücksichtigung der Unterarm-längsachse. *Handchir Mikrochir Plast Chir.* 2000;32:250-259
- Von Laer L, Hasler C. Spontaneous corrections, growth disorders and post-traumatic deformities after fractures in the area of the forearm of the growing skeleton (in German). *Handchir Mikrochir Plast Chir.* 2000;32:231-241.
- Meier R, Prommersberger KJ, van Griensven M, Lanz U. Surgical correction of deformities of the distal radius due to fractures in pediatric patients. *Archives of Orthopaedic and Trauma Surgery.* 2003;124(1):1-9. doi:10.1007/s00402-003-0585-x
- Do TT, Strub WM, Foad SL, Mehlman CT, Crawford AH. Reduction versus remodeling in pediatric distal forearm fractures: A preliminary cost analysis. *J Pediatr Orthop B.* 2003;12:109-15.
- Ring D. Treatment of the neglected distal radius fracture. *Clin Orthop Relat Res.* 2005;431:85-92
- Tarr R, Garfinkel A, Sarmiento A. The effects of angular and rotational deformities of both bones of the forearm. An *in vitro* study. *J Bone Jt Surg Am.* 1984;66:65-70.
- Sarmiento A, Pratt W G, Berry NC, *et al.* Colles' fractures-functional bracing in supination. *J. Bone Joint Surg,* 1975, 57A, 311.
- Sarmiento A, Zagorski JB, Sinclair WF. Functional bracing of Colles' fractures: a prospective study of immobilisation in supination versus pronation. *Clin. Orthop.* 1980;146:175.
- Larsen E, Vittas D, Torp-Pedersen S. Remodeling of angulated distal forearm fractures in children. *Clin Orthop.* 1988;237:190-195
- Wang Q, Wang XF, Iuliano-Burns S, Ghasem-Zadeh A, Zebaze R, Seeman E. Rapid growth produces transient cortical weakness: a risk factor for metaphyseal fractures during puberty. *J Bone Miner Res.* 2010;25(7):1521-1526.
- Faulkner RA, Davison KS, Bailey DA, Mirwald RL, Baxter-Jones AD. Size-corrected BMD decreases during peak linear growth: implications for fracture incidence during adolescence. *J Bone Miner Res.* 2006;21(12):1864-1870.
- Toshiyuki K, Kunihiro O, Tsuyoshi M. Rotational Corrective Osteotomy for Malunited Distal Diaphyseal Radius Fractures in Children and Adolescents. *J Hand Surg Am.* 2018;43(3):286.e1-286.e8.
- Kennedy CABD, Solway S, McConnell S, Bombardier C. Disabilities of the Arm, Shoulder and Hand (DASH). The DASH and QuickDASH Outcome Measure User's Manual. 3rd ed. Toronto, Ontario: Institute for Work & Health, 2011
- Selles CA, Mulders MAM, Roukema GR, van der Vlies CH, Cleffken BI, Verhofstad MHJ, *et al.* Functional Outcomes after Corrective Osteotomy of Symptomatic Distal Radius Malunions in Children. *J Wrist Surg.* 2020;9(02):136-140.
- Richard LD, Wayne AV, Adam WMM, Richard MT, Paul ER. *Gray's Atlas of Anatomy.* 2- ed. Philadelphia. Churchill Livingstone Elsevier. 2018;7:438.