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Research Article

Percutaneous Kirschner Wire Pinning for Salter-Harris II Distal Radius Fractures

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Abstract

Salter-Harris II distal radius physeal injuries are the most common injuries in childhood with no clear treatment guidelines. The initial fracture displacement of more than 50%, children close to skeletal maturity, and failed closed reductions are the indicators for surgical intervention. The purpose of this study is to evaluate the outcome following percutaneous K-wire fixation in displaced SH II injuries. A total of 24 patients (14 male & 10 female) were enrolled in the study under the age of 14 years (mean age: 11±4 years) with displaced physeal injuries with or without ulnar fractures were managed by percutaneous Kirschner wire fixation. The clinical and radiological evaluations were done following fixation with an average follow-up of 4.5 months. Palmer tilt of the radius was equal in 95.8% of the patient; no difference exceeding 10° was seen. The Mayo wrist score at the end of 6 months was 91 (range 85-93). Patient-reported outcomes and wrist motion were almost normal with no or minimal pain at the injury site. So, we recommend K-wire pinning is an easy, safe, effective, and affordable procedure and prevents the chance of secondary displacement.

Keywords: Distal radius; Physis; K-wire

Abbrevations: K-Wire: Kirschner Wire; SH: Salter Harris; VAS: Visual Analogue Scale; DRUJ: Distal Radioulnar Joint; TFCC: Triangular Fibrocartilage Complex

Introduction

Forearm fractures involving either one or both bones are the commonest injuries in the pediatric population among which distal radius fractures are more common (75-84%) [1]. Such injuries involve physis which is of significant value as distal radius physis comprises 70% of longitudinal growth of radius. Salter-Harris II (SH II) injuries are the most common form of physeal injuries which involves the slippage of a triangular fragment of a metaphyseal segment called Thurston-Holland fragment [2]. Despite common occurrence, the treatment guidelines are not clearly defined. Most authors recommend nonsurgical methods such as close reduction and casting [3], while some prefer operative intervention with K-wire fixation for children close to skeletal maturity, significant fracture displacement, and failed close reduction [4]. Substantial evidence suggests better functional outcome is seen without intervention in patients with younger age, distal the fracture, and lesser the angulations [5,6]. Nonsurgical intervention for displaced fractures is the mainstay of treatment but still has a chance of redisplacement (25-39%) [7]. However the use of percutaneous K-wire has shown a decreased rate of redisplacement following fixation [8,9]. Pin track infections, growth arrest, pin migrations, and neurovascular injuries are some potential complications following K-wire fixation [10]. The aim of this study is to analyze the outcome of pinning in SH II injuries clinically and radiologically and examine the incidence of pin-related complications and redisplacement following fixation. This

study also helps to make a treatment guideline for the management of displaced SH II distal radius physeal injuries.

Materials and Methods

This prospective study was conducted in a single academy of health sciences from March 2021 to February 2022 for a period of 1 year after approval from the institutional ethical committee review board. 30 children under the age of 14 years with displaced SH II physeal injuries were treated with percutaneous k wire fixation. (Figure 1) Informed consent was taken and was obtained during regular follow-up. 6 patients missed follow up so only 24 patients were endorsed for the study. Inclusion criteria for operative management were Grade III and Grade IV fractures as per Mani et al [11]. Open fractures, associated with dislocations, previous injuries on the same site, and Grade I and II as per Mani et al[11], and pathological fractures were excluded.

Surgical Techniques

All patients were anesthetized with ultrasound-guided brachial plexus block with or without sedation as per compliance of child. The child was kept in a supine position and reduction was done under an image intensifier. After maintaining reduction a single or double smooth k-wire of size 1.5 mm for small children and 1.8 mm for larger ones was inserted percutaneously. (Figure 2) Two lateral K-wires were kept in 20 patients and in 4 patients only 1 K-wire was kept. Postoperatively long arm cast was applied. (Figure 3) Cast along with K-wire was removed as a daycare procedure after 3-5 weeks. (Figure 4) Then, active wrist and 6-pack finger exercises were started. Follow up were done on 4 weeks, 3 months (Figure 5), and 6 months. Fracture union and any displacement were noted with a plain radiograph. The pain was assessed with the Visual Analogue Scale (VAS), and function was assessed by the Mayo wrist score. Active wrist movements were measured by goniometer on 6-month follow-up and compared with the contralateral side. Statistical analysis was performed using g IBS SPSS Statistics 24.0 where a t-test was evaluated for independent variables and comparisons were done by chi-square test.

Results

Twenty-four children were enrolled in the study were of the age groups ranging from 6 years to 14 years with a mean age of 11±4 years. The ratio of male to female was 7:5 with the involvement of the dominant hand in 62.5%. There were 13 patients with age less than 10 years and the remaining 11 patients were of greater than 10 years of age. The median time of injury to the surgery was of 23 hours (8-48 hr). There were no injuries with neurovascular complications or triangular fibrocartilage complex (TFCC) on MRI. Six patients had ipsilateral ulna styloid fractures. The mean duration of immobilization was 4 weeks [Range 3-6 weeks]. 45.8 % of patients were of G III and 54.2 % were of G IV as per Mani et al classification (Table 1) and displacements with grading were illustrated in Table 2. The mean follow-up was 4.5 months (3-6 months). Five patients developed pin tract infection and 2 patients had pin migration. All patients achieved radiological union with no postoperative DRUJ instability. The Palmar tilt of the radius was equal in 95.8% of the patients; no difference exceeding 10° was seen. Radial inclination and palmar tilt are cited in Table 3. There was no significant displacement in form of radial inclination and palmar tilt with a P-value > 0.05. There was no significant impact on the functional outcomes of age, sex, side of injury, delay in treatment, and postoperative complications. The median visual analog score was 0 [0-2] after 3 months. The range of motion compared to the contralateral wrist is 98% flexion, 90% extension, 80% radial deviation, and 87% ulnar deviation. The Mayo wrist score at the end of 6 months was 91 [range 85-93].

Grading of fractures	Grade III	Grade IV	Total
Male	5 (20.8%)	9 (37.5%)	14 (58.3%)
Female	6 (25%)	4 (16.7%)	10 (41.7%)
Total	11(45.8%)	13 (54.2%)	24 (100%)

Table 1: Severity of translation.

Pattern of fracture	Grade III	Grade IV	Total
Dorso-volar angulation			
Dorsal angulation	10	11	21
Volar angulation	1	2	3
Radio-ulnar angulation			
Radial angulation	8	12	20
Ulnar angulation	0	1	1
Neutral angulation	3	0	3
Ulna styloid fracture			
No fracture	10	8	18
Fracture	1	5	6

Table 2: Pattern of fractures.

Angulations	Radial Inclination		Palmar tilt	
	Male	Female	Male	Female
Equal	12	8	13	10
<10 °	1	2	1	0
>10 °	0	0	0	0

Table 3: Radiographic findings: radial inclination and palmar tilt as compared with the contralateral side.

Discussion

Distal radius physeal injury can be treated conservatively but the chance of redisplacement and malunion is always troublesome. In older children, initial fracture displacement of more than 50% of the diameter of bone, angulations greater than 20°, and failure to achieve perfect reduction were some risk factors[12]. The question always arises during surgery whether we need anatomical reduction or shall we accept suboptimal reduction hoping that remodeling potential is good enough in the child. In the treatment of childhood fractures like supracondylar fracture of the humerus, both radius, and ulna fracture, lateral condyle fractures K-wire have been used for a long but their use in high-risk distal radius physeal injuries has not been so common although many studies had documented significant chance of redisplacement in those fractures following conservative treatment along [11,13]. Our study sample was selected according to initial fracture displacement of greater than 50%, and which subset of groups had a high chance of redisplacement following cast immobilization alone[12]. In the study by Nietosvaara et al [4], the better outcomes were seen with anatomical reduction and percutaneous pinning in children with greater than 50% displacement and not more than 1 year of growth remaining. Zamzam et al [14] recommend the usage of K-wires in all displaced distal radius fractures regardless of reduction while others concluded their use when perfect reduction is not achieved. [9,11-13] In our study, we found the use of K-wire has no translation and none developed radial inclination and palmar tilt greater than 10°. According to Jerome JT, Mayo's wrist scoring following intrafocal K-wire for Salter-Harris II physeal injuries was 84, and no associated injuries to TFCC[15] which was comparable to our study. Pin track infections, migration, scars, neuropraxia, and hypertrophic granulation tissue formations were some potential complications following K-wire fixation[9,16]. In our study 5 patients developed superficial pin tract infection and pin migration was seen in 2 patients. Infectionwas settled after pin removal. Ulnar styloid fracture is commonly associated distal radius fracture. In the study by Zimmermann et al, additional ulnar styloid fractures had no influence on the overall outcome, and neither did they cause instability of the DRUJ, produce wrist pain, or limit the range of motion[12]. Similarly, in our study 6 patients had ulna styloid fracture but have no influence on the overall outcome.

Figure 1: Pre-operative X-ray of Distal radius Salter Harris Type II Physeal Injury.

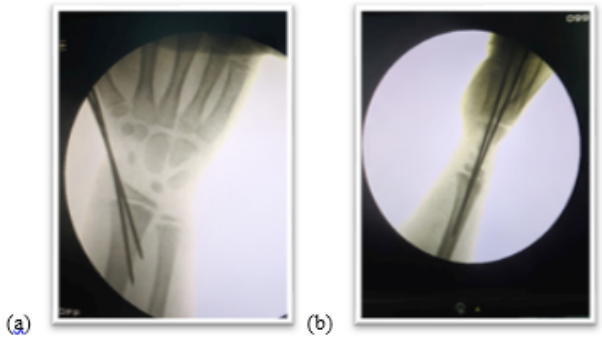

Figure 2: C-Arm images following reduction and K-wire fixation (a) AP view (b) Lateral view.

Figure 3: Immediate postoperative X-ray.

Figure 4: X-ray after 4 weeks.

Figure 5: 3 months postoperative X-ray.

Conclusion

For displaced SH II physeal injuries with a potential chance of redisplacement additional support with K-wire following close reduction should be the procedure of choice. Percutaneous K-wire fixation is an easy, safe, effective, and affordable procedure that further prevents the chance of redisplacement or needs secondary intervention.

Limitation

The limitations of our study are small sample size, short-term follow-up, and lack of a control group. There was no data on long-term growth disturbances in the patient after 6 months.

Consent: It is not applicable.

Competing Interests: Authors have declared that no competing interests exist.

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