

# Comparison of Metaizeau Technique with a Percutaneous K-Wire Fixation for Displaced Radial Neck Fractures in Pediatric Age Group

Comparison of  
Metaizeau  
Technique with a  
Percutaneous  
K-Wire Fixation  
for Radial Neck  
Fractures

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## ABSTRACT

**Objective:** To compare the Metaizeau Technique with a Percutaneous K-Wire Fixation for Displaced Radial Neck Fractures in Pediatric Age Group

**Study Design:** Ambi-directional cohort study

**Place and Duration of Study:** This study was conducted at the Orthopedic Department, Children's Hospital, Lahore from August 1<sup>st</sup>, 2019 to February 28<sup>th</sup>, 2021.

**Materials and Methods:** This was an Ambi-directional cohort study, where a prospective ESIN group was compared with the retrospective percutaneous k-wire group. Out of 35 patients, 16 were in the ESIN group while 19 were in the percutaneous k-wire group. Inclusion criteria were; markedly displaced closed radial neck fractures in children 16 years or less who were operated on within 7 days of injury at Children's Hospital Lahore. The outcome variables were graded according to MEPS score, radiological union, and range of motion. Statistical significance was drawn using a p-value of < 0.05.

**Results:** The mean age of the patients was 10.4±2.4. Based on Judet classification, 22(68%) and 13(38%) had type III and type IV radial neck fractures respectively. The average postoperative follow-up time was 17.2 (6-25) months. Both groups were comparable in terms of MEPS score, ESIN and percutaneous groups had MEPS scores of 75% and 73% respectively. Both ESIN and the percutaneous k-wire group had an excellent radiological alignment in 81% and 84%, respectively. The range of motion was significantly higher in the ESIN group

**Conclusion:** Both closed reduction techniques achieved excellent clinical and radiological outcomes. However, the ESIN group was superior to the percutaneous k-wire group in terms of higher ROM and fewer complications.

**Key Words:** Radial neck fractures, metaizeau technique, titanium elastic nail

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## INTRODUCTION

Pediatric radial neck fractures are uncommon. The average incidence is 5-10% of all elbow fractures in this age group<sup>1</sup>. The axial compressive loading against the capitulum, while falling on the extended hand is the main mechanism of injury<sup>2</sup>.

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Treatment is challenging, depends primarily upon the skeletal age, degree of radial neck fracture angulation, and displacement<sup>3</sup>. Based on the Judet classification (Table 4), most fractures that are either Type I or II are managed conservatively. The surgical option is reserved for markedly displaced fractures of the radial neck with fracture angulation more the 30 degrees (Judet Type III & IV)<sup>4</sup>. Open reduction is restrained for irreducible cases, and fractures with metaphyseal comminution. However, open reduction is discouraged because it is associated with high rates of physical ischemia, premature closure of proximal physis, infection, and heterotrophic ossification<sup>5</sup>. Recent literature favors minimally invasive techniques with closed reduction and internal fixation<sup>1,9</sup>. Closed reduction can be achieved manually or through percutaneous K-wire leverage (PCKWL) technique followed by fixation either with closed elastic stable intramedullary nailing (ESIN)<sup>9</sup> or percutaneous extra-medullary pinning.

ESIN introduced<sup>6</sup> by Metaizeau et al, is an extra-capsular but intramedullary reduction and fixation

technique of displaced fractures of the radial neck. According to this technique, an elastic nail is introduced distally and proceeds proximally to the inferior aspect of the physis, lifting it and pushing it against the capitulum. The initial results are encouraging, as this technique permits closed reduction, preservation of soft tissues, and vascularity around the radial head<sup>12</sup>. Complications related to this technique are; difficulty in reducing fracture segments, stable fixation, and superficial radial nerve injury<sup>1</sup>.

In our study, we used the same modified ESIN technique. To our knowledge, this is probably the first study in our country and among the very few studies internationally<sup>17</sup> that compares the results and complications in ESIN versus percutaneous extra-medullary K-wire fixation for displaced fractures of the radial neck. This study will help in making local guidelines for best treating such challenging fractures.

## MATERIALS AND METHODS

A prospective, conveniently sampled cohort study was carried out at the orthopedic department, children's hospital, Lahore from August 1<sup>st</sup> 2019 to February 28<sup>th</sup> 2021. Inclusion criteria were: closed fractures of radial neck, fractures presented equal to or less than 7 days, markedly displaced radial neck fractures (Judet type III and IV) in children aged 16 years or less (in whom physical plate is not fused on x-rays). Exclusion criteria were: radial neck fractures that required open reduction, open fractures, and radial neck fractures associated with concomitant ipsilateral upper limb fractures.

**Surgical technique:** Patient lying in the supine position and the affected elbow extended under C-arm; closed reduction is first tried with the thumb pressing over the radial head while sustaining traction and valgus stress at the involved elbow. Manual reduction if not possible then reduction achieved through percutaneous k-wire leverage (PCKWL) technique, as used by Kapandji<sup>21</sup>, a percutaneous k-wire under C-arm is engaged at the proximal fracture site and leveraged to optimum reduced position till stabilized by ESIN or percutaneous K-wire fixation as explained below.

**Elastic stable intramedullary nailing:** An elastic nail of 1.2mm to 2 mm depending on the patient's age, is contoured at the tip at an angle of 30°-45°. Under the image intensifier, a 0.5-1cm incision is given cranial to the distal radius physis. Careful tissue dissection is done to spare the sensory branch of the radial nerve; the entry is made at the radial cortex through a trochar. An elastic nail is inserted through the proximal entry point and pushed proximally until it engages the lower part of the radial head epiphysis. The anatomical reduction of the fracture is confirmed under C-arm. The remaining distal part of the flexible nail is cut and embedded into the soft tissue, and a long arm POP is applied.

**Percutaneous k-wire fixation:** Under fluoroscope fracture site is identified. While maintaining the

fracture reduction through manual or PCKWL technique, a k-wire size 1.5mm-2mm is drilled across the fracture from the radial border of proximal to ulnar border of distal fracture segment. Fracture reduction and stability checked under C-arm, if required additional k-wires are passed. A long arm POP cast is then applied.

**Follow-up and outcome measures:** The follow-up protocol for both techniques was; at 3 weeks, 6 weeks, 3 months, 6 months, and 1 year. For the ESIN group, physiotherapy for a range of motion started at 3 weeks after removal of the cast. In the K-wire group, cast and k-wire were removed at 3 weeks post-operative, and a long arm slab was applied for another 3 weeks. Physiotherapy started at 6 weeks period. At each postoperative visit, radiographic and clinical evaluations were documented. The radial head tilt was measured on the lateral elbow radiograph as an angle made at the intersection of two lines; a longitudinal line along the anterior surface of the distal humerus and another along the upper border of the radial head. The radiographic outcome was graded excellent if anatomic reduction, good if angle less than 20°, moderate if the angle between 20°-40°, and poor if more than 40°. The Mayo Elbow Performance Score (MEPS), as shown in table 2, was used for clinical grading.

For statistical analysis, SPSS version 21 was used. P-value of <.05 was considered significant. Statistical significance was drawn with a two-sided t-test; if the data was parametric. For non-parametric distribution, an independent sample t-test was used.

## RESULTS

A total of 35 patients (ESIN group=16, K-wire group=19) were included in the study. Both groups were comparable in terms of demographics, with the mean age of 10.4 years  $\pm$  2.4 (6-16 years). The boys were more than girls (71% vs 29% respectively). The mean postoperative follow-up time was 17.2  $\pm$  5.4 (6-25) months. The right side was involved in 59%. There were 22 (62%) type III while 13 (38%) cases had type IV fractures according to Judet classification. The MEPS and radiological scores were comparable in both groups. MEPS scores for ESIN and k-wire groups were 75% and 73% respectively. The radiological score was slightly higher for ESIN compared to the k-wire group (84% vs 81%), however, the results were statistically not significant.

Markedly displaced fractures (Type IV) had relatively poor clinical and radiological outcomes as compared to Judet type III fractures as shown in table (1). A statistically significant higher ROM was seen in the ESIN than the percutaneous k-wire group, as shown in table (2). 4 patients developed minor complications in the percutaneous k-wire group; two patients had superficial pin tract infection, while another two developed asymptotically enlarged radial head. None

of our patients in both groups had any major infection, heterotrophic calcification, or early closure of complications e.g., nonunion, avascular necrosis, proximal radial physis.

**Table No.1: Clinical and radiological comparison between ESIN and percutaneous groups**

	MEPS				Radiological alignment	
	Excellent N (%)	Good N (%)	Medial N (%)	Poor N (%)	Excellent N (%)	Good N (%)
ESIN Group						
Total cases (N=16)	12(75%)	4(25%)	-	-	13(81%)	3(19%)
Type III (N=10)	8(80%)	2(20%)	-	-	9(90%)	1(10%)
Type IV (N=6)	4(66%)	2(34%)	-	-	4(66%)	2(34%)
Percutaneous K-wire Group						
Total cases (N=19)	14(73%)	4(21%)	1(5%)	-	16(84%)	3(16%)
Type III (N=12)	10(83%)	2(17%)	-	-	11(91%)	1(9%)
Type IV (N=7)	4(57%)	2(28%)	1(14%)	-	5(71%)	2(29%)

**Table No.2: Group comparison and statistical analysis**

	MEPS	Radiological alignment (°)	Range of motion (°)			
			Flexion	extension	Pronation	Supination
ESIN (N=16)	90.01 ± 6.43	1.82 ± 4.85	2.8 ± 2.36	0.96 ± 0.58	0.00 ± 0.00	0.00 ± 0.00
Percutaneous K-wire (N=19)	90.09 ± 8.61	2.97 ± 6.34	30.58 ± 23.71	5.14 ± 6.23	10.89 ± 13.59	16.33 ± 28.91
ESIN VS Percut K-wire	0.98	0.64	0.003	0.016	0.015	0.145

**Table No.3: Mayo elbow performance score (MEPS)**

Variable	Definition	No. of points
Pain max. (45 points)	None	45
	Mild	30
	Moderate	15
	Severe	0
Range of motion max. (20 points)	Arc > 100	20
	Arc 50 – 100	15
	Arc < 50	5
Stability max. (10 points)	Stable	10
	Moderately unstable	5
	Grossly unstable	0
Function max. (25 points)	Able to comb hair	5
	Able to feed oneself	5
	Able to perform personal hygiene	5
	Able to put on shirt	5
	Able to put on shoe	5

**Table No.4: Judet Classification for fracture neck of radius**

Type	Angulated angle (°)	Displacement (%)
I	No	No
II	> 30	< 1/2 of transverse diameter of fracture
III	30-60	> 1/2 of transverse diameter of fracture
IV	> 60	Complete displacement

## DISCUSSION

About 50% of displaced fractures of the radial neck are combined with additional injuries around the elbow including; distal humerus, proximal ulna, and ligamentous injuries<sup>7</sup>. Treatment modalities are controversial and broadly depend upon the patient's age, fracture displacement, and degree of radial head angulation<sup>8</sup>. Generally, radial head fractures with tilt less than 30° (Judet type I and II) are successfully treated with conservative management. Operative treatment is reserved for Judet type III and IV fractures in whom angulation is more than 30°<sup>9</sup>.

Surgical options for displaced fractures of radial neck discussed in the recent literature are; closed reduction and percutaneous k-wire fixation<sup>8</sup>, ESIN<sup>8</sup>, open reduction, and internal fixation. The radial neck fractures are vulnerable to ischemic changes as the main blood supply to proximal epiphysis is retrograde from its metaphysis. Displaced fractures disturb blood supply, tissue dissection during open reduction further jeopardizes this blood supply and increases the chances of avascular necrosis of the radial head<sup>9,10</sup>. Open reduction is discouraged by many authors because of complications including; AVN of the radial head, heterotrophic ossification, infections, and elbow stiffness<sup>11</sup>, therefore, open reduction is reserved mainly for failed closed reduction, severely comminuted fractures, and fracture-dislocations<sup>12</sup>.

Closed reduction and internal fixation in the form of closed intramedullary pinning (CIMP), extramedullary K-wire fixation, and ESIN are considered for treating displaced type III and IV fractures of the radial neck<sup>13</sup>. The ESIN technique; was introduced by Metaizeau in 1980; later modified in 1993 by using elastic intramedullary nails. This is a minimal invasive closed reduction technique that reduces fracture, provides stable fixation, and avoids the complications associated with ORIF<sup>14</sup>. The success reports of this technique are promising, few drawbacks mentioned in the literature are; difficulty in reduction of highly displaced fractures, and loss of reduction due to slippage of blunt tip of the flexible nail with the subsequent possibility of second procedure<sup>15</sup>. Manual reduction is often insufficient, especially in markedly displaced, angulated, and comminuted fractures, and may require a percutaneous k-wire leverage technique for reduction<sup>16</sup>. In our series manual reduction was possible in only 3 patients, for the rest of the patients we had to combine manual reduction and percutaneous leverage technique (PKWL) to achieve the desired reduction.

To our knowledge, there are very few studies comparing the ESIN technique with a percutaneous k-wire fixation for displaced radial neck fractures, in terms of clinical and radiological outcomes. In our study, both groups were comparable in terms of clinical outcome (MEPS score), and radiological outcome

including fracture alignment and healing time. Our results are comparable to Klitscher et al<sup>17</sup>, who achieved excellent results in 82% and 71% cases respectively. The range of motion (ROM) was significantly higher in the ESIN group, as shown in table (2). Decreased ROM in the PKWL group is best explained by the fact, that the protruding k-wire in the percutaneous k-wire fixation technique prevents an early range of motion at the elbow and hence require prolonged immobilization (6 weeks) as compared to the ESIN group when the cast is removed at 3 weeks and range of motion exercises started. We did not observe any major complication in both groups, however, the PKWL group had four minor complications including; two patients had an asymptotically enlarged radial head while another two had a pin site infection, both of them treated conservatively.

A major complication of the Metaizeau technique mentioned in the literature is the inability to maintain reduction. The blunt tip of the flexible nail is unable to obtain a good purchase of the radial head resulting in slippage of flexible nail across the fracture site, resulting in an increased percentage of secondary procedures of 10 percent or more (30). We used the technique as described by Rahi KY et al<sup>18</sup>, while maintaining the bow, the blunt tip is sharpened by cutting it in diamond/rhomboid shape, which not only assists the smooth passage of the tip across the fracture site but also provides 3-dimensional stable purchase at the radial head. In our series, using this technique all fractures had stable fixation and there was no case of flexible nail slippage or loss or reduction.

## CONCLUSION

In conclusion, closed fixation of displaced radial head fractures produces excellent results with fewer complications. In our series, ESIN and Percutaneous K-wire fixation are comparable regarding clinical and radiological outcomes. However, the ESIN technique is superior in terms of better ROM and fewer complications.

### Author's Contribution:

Concept & Design of Study:	Islam Hussain
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**Conflict of Interest:** The study has no conflict of interest to declare by any author.

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