



COMPARISON OF FUNCTIONAL AND RADIOLOGICAL OUTCOME OF CLOSED REDUCTION AND K-WIRE FIXATION USING JOYSTICK TECHNIQUE AND CONVENTIONAL TECHNIQUE IN MANAGEMENT OF SUPRACONDYLAR HUMERUS FRACTURE: A PROSPECTIVE STUDY

Orthopaedics

Dr Shashank Jindal

Associate Professor, Department of Orthopaedics, LLRM Medical College Meerut.

Dr Pankaj Rathore Assistant Professor, Department of Orthopaedics, LLRM Medical College Meerut.

Dr Saurav Anand* Junior Resident, Department of Orthopaedics, LLRM Medical College Meerut.
*Corresponding Author

Dr Kritesh Mishra Assistant Professor, Department of Orthopaedics, LLRM Medical College Meerut.

ABSTRACT

Background: Supracondylar humerus fractures are the most common elbow injuries in children and often lead to complications such as neurovascular compromise and malunion. Closed reduction and percutaneous pinning (CRPP) is the standard treatment; however, achieving proper reduction can be difficult in severely displaced fractures. The joystick technique, using a temporary K-wire for controlled manipulation, offers improved reduction accuracy and surgical efficiency. **Objective Of The Study:** To compare the functional and radiological outcomes of the joystick-assisted and conventional CRPP techniques in paediatric supracondylar humerus fractures. **Methods:** This prospective cohort study was conducted at L.L.R.M. Medical College, Meerut, from June 2023 to April 2025 on 78 children under 12 years with Gartland type III and IV fractures. Group A (n=38) underwent conventional CRPP, while Group B (n=40) received joystick-assisted CRPP. Operative parameters, radiological findings (Baumann's and carrying angles), and functional outcomes (Flynn's criteria) were assessed using SPSS v26.0, with $p < 0.05$ considered significant. **Results:** Group B showed significantly shorter operative time, fewer fluoroscopy exposures, and fewer reduction attempts compared to Group A ($p < 0.001$). The carrying angle improved significantly in Group B ($p = 0.002$), while Baumann's angle remained comparable. Functionally, 55% of Group B achieved excellent outcomes versus 42.1% in Group A ($p = 0.379$). **Conclusion:** The joystick-assisted CRPP technique enhances operative efficiency and radiological alignment while maintaining comparable functional results. It is a safe, simple, and effective modification for paediatric supracondylar humerus fractures.

KEYWORDS

Supracondylar humerus, joystick technique, K-wire fixation, closed reduction, paediatric fractures.

INTRODUCTION

Supracondylar fractures of the humerus constitute approximately 17% of all childhood fractures and are the most common elbow injury in the paediatric population (1). These injuries are clinically important due to their association with neurovascular compromise, malunion, and the development of cubitus varus deformity, leading to both cosmetic and functional impairment (2). Gartland's classification, later modified by Wilkins, remains the standard system for categorizing these fractures based on displacement and cortical integrity (3).

Such fractures typically result from a fall on an outstretched hand or direct trauma to the elbow, with an estimated incidence of 177.3 per 100,000 children. They most commonly occur around six years of age, with a higher prevalence in boys and a tendency to affect the non-dominant limb (4). Despite significant advancements in paediatric orthopaedic techniques, displaced supracondylar fractures remain challenging to manage. Inadequate reduction can lead to serious complications such as malunion, Volkmann's ischaemic contracture, nerve injury, skin slough, and myositis ossificans, underscoring the need for precise reduction and stabilization (5–8). Closed reduction and percutaneous pinning (CRPP) using Kirschner wires (K-wires) is widely accepted as the gold-standard treatment for displaced fractures (9–11). The conventional CRPP technique employs crossed or lateral divergent pin configurations to achieve stability with minimal soft-tissue disruption. However, achieving satisfactory alignment in cases with severe displacement or rotational deformity can be technically demanding and often increases operative and fluoroscopy time.

To address these limitations, the joystick technique has been introduced as a simple, low-cost adjunct to conventional reduction. In this method, a temporary percutaneous K-wire is inserted into the distal fragment to act as a joystick, allowing precise control of rotational and translational alignment before definitive fixation (11,12). Early studies indicate that this technique enhances reduction accuracy, reduces operative time, and minimizes radiation exposure without increasing complications (11,12). Hence, this study aimed to compare the functional and radiological outcomes of joystick-assisted and conventional CRPP in paediatric supracondylar humerus fractures to establish a safer, more effective surgical approach for optimal patient outcomes.

Objective Of The Study

To compare the functional and radiological outcome of closed

reduction and K-wire fixation using the conventional technique and the novel joystick technique.

MATERIAL AND METHODS

This prospective cohort study was conducted in the Department of Orthopaedics, L.L.R.M. Medical College and associated S.V.B.P. Hospital, Meerut, from June 2023 to April 2025. Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was secured from all parents or guardians.

The study followed the principles of the Declaration of Helsinki. Children below 12 years with displaced supracondylar humerus fractures were included. A total of 78 patients were enrolled—38 treated by the conventional closed reduction and percutaneous pinning technique (Group A) and 40 by the joystick-assisted method (Group B). The sample size was derived from the formula $n = 3.84 pq / e^2$ at a 90% confidence interval.

Inclusion Criteria:

- Children < 12 years undergoing K-wire fixation by conventional or joystick technique.
- Presentation within two weeks of injury.
- No neurovascular deficit.
- Informed consent obtained.
- Gartland type III or IV fractures.

Exclusion Criteria:

- Associated forearm fractures.
- Stiff elbow or pre-existing deformity.
- Pathological or congenital upper-limb anomalies.
- Refusal of operative management.

All patients underwent clinical and radiographic evaluation, including anteroposterior and lateral X-rays to assess fracture displacement and rotation. Surgeries were performed under general anaesthesia with fluoroscopic guidance. In Group A, reduction was achieved by traction and correction of coronal and sagittal alignment, followed by fixation with 1.6–2.0 mm K-wires in crossed or lateral divergent configuration. In Group B, an additional 2.5 mm K-wire was inserted anterolaterally below the deltoid attachment (safe zone, Zone V–VII) as a joystick to correct rotational or translational deformity before final fixation, and then removed. A single prophylactic antibiotic dose was given 30

minutes before surgery. Postoperatively, a long-arm posterior slab was applied for three weeks with early finger and shoulder mobilisation. K-wires were removed at three weeks, and elbow exercises initiated. Follow-ups were done at 3 weeks, 6 weeks, 3 months, and 6 months. Clinical evaluation included elbow range of motion, ulnar nerve function, and reduction stability; radiological parameters assessed were Baumann's angle, carrying angle, and humerocapitellar angle. Operative time, reduction attempts, total fixation attempts, and fluoroscopy exposures were documented. Data were analysed using SPSS v26.0, applying Student's t-test and Chi-square test, with $p < 0.05$ considered significant.

PHOTOGRAPHS



RESULTS

A total of 78 patients were divided into Group A (conventional K-wire fixation) and Group B (joystick-assisted method). Most patients (59.0%) were aged 5–8 years, with a mean age of 6.86 ± 2.44 years (range: 1–12 years). There was a clear male predominance (69.2% males, 30.8% females; ratio 2.25:1), indicating boys were more frequently affected.

Table 1: Distribution Of Cases According To Age Group And Gender Between The Two Study Groups

Parameter	Sub-group	Group A (n = 38)	Group B (n = 40)	Chi-square value / t-value	p-value
Age Group	1–3 years	8 (21.1%)	18 (45.0%)	6.814	0.033*
	5–8 years	25 (65.8%)	21 (52.5%)		
	9–12 years	5 (13.2%)	1 (2.5%)		

	Mean ± SD (years)	7.58 ± 2.45	6.17 ± 2.25	t = 2.639	0.010*
Gender	Male	23 (60.5%)	31 (77.5%)	2.636	0.104
	Female	15 (39.5%)	9 (22.5%)		

*Significant at $p < 0.05$

Table 1 shows that younger patients predominated in Group B, with a significantly lower mean age ($p = 0.010$). Gender distribution showed male predominance overall but no significant intergroup difference ($p = 0.104$).

Figure 1 shows that most fractures involved the left side, indicating higher involvement of the non-dominant limb, consistent with common injury patterns in paediatric supracondylar humerus fractures.

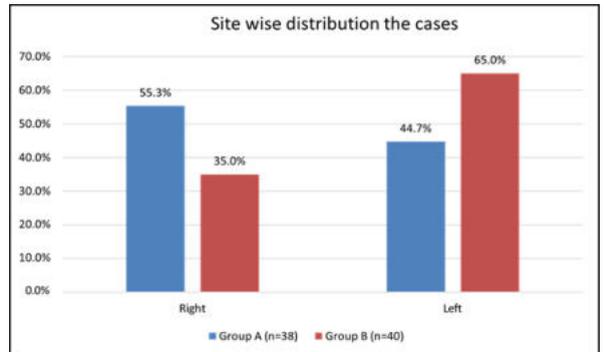


Figure 1: Site-wise Distribution Of The Cases

Table 2 shows that Group B had significantly shorter operative time, fewer fluoroscopy exposures, and fewer reduction attempts compared to Group A ($p < 0.001$), confirming better intraoperative efficiency with the joystick technique.

Table 2: Intraoperative Findings Comparison In Both Groups

	Group		t-value	p-value
	Group A (n=38)	Group B (n=40)		
Operation time (min)	33.92±7.79	25.20±3.83	6.323	<0.001
No of C arm shots	30.50±7.72	13.82±3.28	12.520	<0.001
Attempt for reduction	4.47±2.13	2.10±1.10	6.229	<0.001
Total Reduction attempts in final fixation	11.53±2.80	8.32±2.56	5.281	<0.001
Time Reduction (min)	26.82±7.20	13.10±2.27	11.466	<0.001

Figure 2 shows comparable Baumann's angles between groups, but Group B demonstrated improved carrying angle restoration, indicating better radiological alignment achieved with the joystick-assisted method.

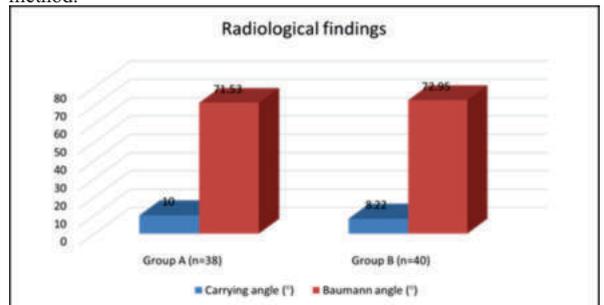


Figure 2: Comparison Of Radiological Findings In Both Groups

Table 3 shows that postoperative range of motion was significantly higher in Group B ($p = 0.020$), suggesting faster recovery and superior elbow mobility after joystick-assisted fixation.

Table 3: Comparison Of The Postoperative Range Of Motion

Range Of Motion (°)	Group		Chi Square Value	P value
	Group A (n=38)	Group B (n=40)		
10-70	2 (5.3%)	0 (0.0%)	16.655	0.020

10-80	7 (18.4%)	4 (10.0%)	
10-90	2 (5.3%)	10 (25.0%)	
10-100	3 (7.9%)	2 (5.0%)	
20-70	14 (36.8%)	9 (22.5%)	
20-80	4 (10.5%)	9 (22.5%)	
20-90	5 (13.2%)	1 (2.5%)	
30-70	1 (2.6%)	5 (12.5%)	

Table 4 shows that functional outcomes based on Flynn's criteria were better in Group B, with more excellent results (55% vs 42.1%), though the difference was not statistically significant ($p=0.379$).

Table 4: Functional Outcomes Based On Flynn's Criteria And Fixation Types

Flynn's criteria	Group		Chi-Square value	P value
	Group A (n=38)	Group B (n=40)		
Excellent	16 (42.1%)	22 (55.0)	3.08	0.379
Good	10 (26.3)	12 (30.0)		
Fair	12 (31.6)	6 (15.0)		
Poor	0 (0.0%)	0 (0.0%)		

DISCUSSION

This study evaluated the functional and radiological outcomes of closed reduction and percutaneous K-wire fixation using the joystick technique compared with the conventional method in 78 paediatric patients with supracondylar humerus fractures. The mean age of the study population was 6.86 ± 2.44 years, with a predominance of males (69.2%), findings consistent with earlier studies by Kumar B et al. (12) and Parmaksizoglu AS et al. (13), who reported a mean age of 6–7 years and male predominance in similar cohorts. The majority of cases in the present study were within the 5–8 year age group, aligning with previously reported epidemiological patterns of paediatric supracondylar fractures (14,15). Left-sided involvement (55.1%) was also more common, which corresponds to the higher frequency of injury to the non-dominant limb observed in other studies (14,15).

Intraoperatively, the joystick-assisted group demonstrated significantly improved surgical efficiency, with reduced operative time (25.20 min vs 33.92 min), fewer fluoroscopic exposures (13.82 vs 30.50), and fewer reduction attempts (2.10 vs 4.47) compared to the conventional group ($p < 0.001$). These findings correspond with those of Kumar S et al. (16) and Patel A et al. (17), who reported shorter surgical times and improved reduction accuracy with the joystick technique. The enhanced control and precision provided by the intrafocal joystick K-wire likely contributed to this improved intraoperative efficiency.

Radiologically, Group B exhibited a significantly smaller carrying angle ($8.22^\circ \pm 2.78^\circ$ vs $10.00^\circ \pm 1.87^\circ$, $p = 0.002$) with comparable Baumann angles between groups ($p = 0.056$). Similar findings were noted by Kumarjuvekar SA et al. (11) and Parmaksizoglu AS et al. (13), who observed significant improvement in Baumann and carrying angles following joystick-assisted reduction. Other studies, including those by Lee BJ et al. (18) and Kocher MS et al. (19), also found no significant long-term difference in Baumann's angle between fixation methods, reinforcing the consistency of radiological alignment outcomes.

The postoperative range of motion differed significantly between the two groups ($p = 0.020$), with a higher proportion of patients in Group B achieving greater elbow mobility. Comparable improvements in motion have been reported by Rizk AS and Tabl EA (20) and Turgut A et al. (21), indicating faster functional recovery with joystick-assisted fixation.

Based on Flynn's criteria, Group B showed a higher proportion of excellent results (55.0% vs 42.1%), though the difference was not statistically significant ($p = 0.379$). These results align with those of Kumar B et al. (12) and Parmaksizoglu AS et al. (13), who reported improved precision of reduction and favorable functional outcomes with the joystick technique. Similarly, Naik LG (22) and Tiwari A et al. (23) demonstrated 80–88% excellent results with surgical management of displaced fractures.

The advantages of the joystick method are its simplicity, cost-effectiveness, and ability to achieve controlled reduction while minimizing the need for open procedures. The technique helps prevent

rotational malalignment and facilitates accurate fracture alignment with minimal soft-tissue trauma.

However, this study has limitations. The sample size was modest, and radiation exposure during fluoroscopy was not quantified. Longer follow-up and multicentre randomized trials are required to validate long-term functional and radiological outcomes.

CONCLUSION

We concluded that the joystick-assisted closed reduction and percutaneous K-wire fixation technique provides better surgical efficiency and radiological alignment than the conventional method for paediatric supracondylar humerus fractures. It significantly reduced operative time, fluoroscopy exposure, and reduction attempts while maintaining comparable functional outcomes. Though the difference in Flynn's criteria was not statistically significant, the joystick method proved to be a safe, simple, and effective adjunct, improving reduction accuracy and facilitating better overall management.

Declaration

Conflict Of Interest: None.

Funding: None.

Ethical Approval: Obtained.

Consent: Written consent secured.

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