



Original Article

Functional Outcome of Displaced Supracondylar Humerus Fractures Treated With Conventional Cross Pinning Method Versus Lateral Only Cross Pinning (Dorgan's Technique)- A Randomised Control Study

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Received: 06-03-2026

Accepted: 03-20-2026

Available online: 09-04-2026

ABSTRACT

Background: Supracondylar fractures of the humerus are among the most common pediatric elbow fractures. Closed reduction and percutaneous pinning is the standard treatments for displaced fractures. However, the optimal pin configuration remains controversial due to concerns regarding stability and complications, particularly ulnar nerve injury.

Objective: To compare the functional and cosmetic outcomes, operative parameters, and complication rates between conventional cross pinning and Dorgan's lateral cross pinning technique in pediatric supracondylar humerus fractures.

Materials and Methods: This prospective randomised controlled study was conducted on 68 pediatric patients with displaced supracondylar humerus fractures (Gartland type II and III). Patients were randomly allocated into two groups: Group I (conventional cross pinning) and Group II (Dorgan's lateral cross pinning), with 34 patients in each group. Patients were followed up for 6 months. Outcomes assessed included operative time, fracture union, range of motion, complications, and functional and cosmetic results using Flynn's criteria. Statistical analysis was performed using SPSS, with $p < 0.05$ considered significant.

Results: The mean operative time was significantly shorter in the conventional group (15.18 ± 4.11 minutes) compared to the Dorgan group (24.24 ± 5.15 minutes) ($p < 0.001$). However, union time was comparable between groups ($p = 0.855$). The Dorgan group showed significantly better pronation and supination ($p < 0.001$), while flexion was similar in both groups. Complication rates were low, with one case of ulnar nerve injury observed only in the conventional group. Functional outcomes were excellent in 91.2% of cases in the conventional group and 97.1% in the Dorgan group. Cosmetic outcomes were excellent in 97.1% of patients in both groups.

Conclusion: Both techniques provide excellent outcomes with minimal complications. While conventional cross pinning is faster, Dorgan's lateral cross pinning offers comparable stability with better rotational outcomes and improved safety, making it a preferable alternative in pediatric supracondylar fractures.

Keywords: Supracondylar humerus fracture; Pediatric fractures; Cross pinning; Dorgan's technique; Lateral pinning; Percutaneous pinning; Flynn's criteria; Ulnar

INTRODUCTION

Supracondylar fractures of the humerus represent one of the most common orthopedic injuries encountered in the pediatric population. They account for approximately 50–70% of all elbow fractures in children and nearly 3–5% of all pediatric fractures, making them a significant contributor to morbidity in this age group (1,2). These fractures most commonly occur in children between 4 and 12 years of age, coinciding with increased physical activity and vulnerability of the developing skeleton (3).

The typical mechanism of injury is a fall on an outstretched hand, resulting in hyperextension at the elbow and leading predominantly to extension-type fractures, which constitute about 95–98% of cases (4). Flexion-type injuries are relatively rare but may be associated with a higher incidence of complications. The anatomical features of the distal humerus in children, including a thin cortex and a relatively weak supracondylar region, predispose this area to fracture under stress (5).

The widely used Gartland classification system categorizes supracondylar fractures into Type I (undisplaced), Type II (displaced with intact posterior cortex), and Type III (completely displaced) fractures (6). While Type I fractures can often be managed conservatively, Type II and III fractures usually require surgical intervention due to instability and the risk of displacement (7).

Management of displaced supracondylar fractures is critical, as improper treatment can lead to serious complications such as malunion (cubitus varus deformity), neurovascular injury, compartment syndrome, Volkmann's ischemic contracture, and restricted range of motion (8,9). Among these, cubitus varus deformity (gunstock deformity) is the most common late complication, often resulting from inadequate reduction or fixation (10).

Over the years, closed reduction and percutaneous pinning (CRPP) has emerged as the gold standard treatment for displaced supracondylar fractures, offering the advantages of stable fixation, minimal soft tissue disruption, and early mobilization (11). The goal of treatment is to achieve and maintain anatomical reduction while minimizing complications and restoring full function.

Various pinning configurations have been described in the literature, with cross pinning (medial and lateral pins) and lateral-only pinning being the most commonly used techniques. Cross pinning is traditionally considered to provide superior biomechanical stability, particularly in resisting rotational forces, due to the divergent configuration of pins across both columns of the distal humerus (12). However, insertion of the medial pin carries a risk of iatrogenic ulnar nerve injury, with reported incidence ranging from 1% to 8%, especially when the elbow is hyperflexed during pin placement (13,14).

In an effort to reduce the risk of ulnar nerve injury, lateral-only pinning techniques have gained popularity. Among these, Dorgan's lateral cross pinning technique is a modification in which both pins are inserted from the lateral side, with one pin directed medially across the fracture site. This technique aims to combine the safety of lateral pinning with the stability of cross pinning, thereby avoiding medial pin insertion while maintaining adequate fixation strength (15).

Several biomechanical and clinical studies have compared these pinning methods. While some authors have demonstrated that lateral pinning provides comparable stability and fewer complications, others argue that cross pinning offers better resistance to rotational displacement, particularly in completely displaced fractures (16,17). The choice of technique often depends on surgeon preference, fracture pattern, and intraoperative stability.

Despite extensive research, there remains ongoing controversy regarding the optimal pin configuration that provides the best balance between mechanical stability and safety. The risk of ulnar nerve injury with cross pinning must be weighed against the potential for loss of reduction with lateral-only constructs.

Therefore, the present study was undertaken to compare the functional and cosmetic outcomes, operative parameters, radiological union, and complication rates between conventional cross pinning and Dorgan's lateral cross pinning technique in the management of displaced supracondylar fractures of the humerus in children. The study aims to provide further evidence to guide the selection of an optimal surgical technique that ensures both effective fracture stabilisation and minimal complications.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective randomised controlled study conducted in the Department of Orthopaedics at B.L.D.E. (Deemed to be University) Shri B. M. Patil Medical College, Hospital and Research Centre, Vijayapura, Karnataka, India. The study was carried out from 1st March 2024 to 31st December 2025.

Study Population

A total of 68 pediatric patients diagnosed with displaced supracondylar fractures of the humerus were included in the study. Among them, 44 (64.7%) were males, and 24 (35.3%) were females. Right-sided injury was observed in 35 (51.4%) patients, while 33 (48.6%) had left-sided involvement.

Sample Size Calculation

The sample size was calculated based on the expected difference in the incidence of iatrogenic ulnar nerve injury between the two pinning techniques. Based on previous literature, the incidence was estimated to be 3.4% for conventional cross pinning and 0.7% for Dorgan's lateral cross pinning technique. Using these proportions, a total sample size of 68 patients (34 per group) was required to achieve 80% power at a 5% level of significance. The calculation was performed using G*Power software version 3.1.9.7 (Z-test for difference between two independent proportions).

Inclusion Criteria

- Patients aged 4–12 years
- Closed displaced supracondylar humerus fractures (Gartland type II and III)

Exclusion Criteria

- Open (compound) fractures
- Pathological fractures
- Fractures with neurovascular injury
- Polytrauma patients

Patient Recruitment and Consent

Eligible patients who satisfied the inclusion criteria were enrolled after obtaining written informed consent from parents or guardians. A detailed history and thorough clinical examination were performed, including assessment of neurovascular status.

Randomization and Allocation

Patients were randomly allocated into two groups using a computer-generated randomization method with a 1:1 allocation ratio:

- Group A: Conventional cross pinning (medial and lateral pins)
- Group B: Dorgan's lateral cross pinning technique

This was a two-arm randomized controlled study, and no blinding was performed.

Surgical Technique

All procedures were performed under general anaesthesia or brachial plexus block. Prophylactic intravenous antibiotics (ceftriaxone) were administered 30 minutes prior to surgery.

Patients were positioned supine with the affected limb on a radiolucent arm board. Closed reduction was attempted in all cases using standard techniques involving traction, correction of displacement, and flexion of the elbow. Reduction was confirmed using fluoroscopy (C-arm) in anteroposterior and lateral views.

- Conventional Cross Pinning (Group A):
A lateral pin was inserted first. A small incision was made over the medial epicondyle, and the ulnar nerve was identified and protected before insertion of the medial pin.
- Dorgan's Technique (Group B):
After insertion of the first lateral pin, a second lateral pin was introduced from the proximal fragment under fluoroscopic guidance, directed toward the medial epicondyle.

Postoperative Care

An above-elbow slab was applied with the elbow in approximately 60° flexion.

- Intravenous antibiotics were continued for 48 hours
- Wound inspections were done on postoperative days 2, 5, and 8
- Finger mobilization was initiated immediately
- K-wires were removed at 4 weeks, followed by active and passive elbow mobilization

Patients were advised to avoid heavy activities until fracture healing was confirmed.

Follow-Up and Outcome Assessment

Patients were followed up at 6 weeks, 3 months, and 6 months.

At each follow-up, the following were assessed:

- Clinical evaluation (range of motion, complications)
- Radiological assessment (fracture union, Baumann's angle)
- Complications (pin tract infection, ulnar nerve injury, loss of reduction)

Functional and cosmetic outcomes were evaluated using Flynn's criteria. Radiological union was assessed using anteroposterior and lateral radiographs.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS version 22.0.

- Continuous variables were expressed as mean \pm standard deviation (SD) or median (IQR)
- Categorical variables were expressed as frequency and percentage

Statistical tests used:

- Independent t-test / Mann-Whitney U test for continuous variables
- Chi-square test / Fisher's exact test for categorical variables
- Pearson or Spearman correlation for associations

Relative risk (RR) with 95% confidence intervals (CI) was calculated where applicable.

A p-value < 0.05 was considered statistically significant.

RESULTS AND OBSERVATIONS

A total of 68 cases of closed supracondylar humerus fractures were included in the study, with no loss to follow-up over a minimum period of 6 months. The majority of injuries were due to a fall on an outstretched hand (92.6%), while 7.4% were due to road traffic accidents.

There was a male predominance (64.7%), and fractures were almost equally distributed between the right (51.4%) and left (48.6%) sides. According to the Gartland classification, 29 cases were Type II and 39 cases were Type III fractures.

All patients underwent surgical fixation within 0–3 days of admission, with 20.6% operated on an emergency basis and the remaining electively. Patients were equally divided into two groups: Conventional cross pinning (Group I) and Dorgan's lateral cross pinning (Group II).

Radiological assessment in the immediate postoperative period showed adequate reduction in all cases, with proper alignment and restoration of the anterior humeral line. Fracture union was achieved in all patients within 6–8 weeks, and K-wire removal was performed at 4–6 weeks. Functional recovery was satisfactory, with near full range of motion achieved by 6 months.

Complications were minimal. Superficial pin tract infection occurred in 2 cases (one in each group) and resolved with conservative management. Varus angulation of 5° was noted in 2 cases (one in each group), without functional limitation. One case of ulnar nerve neuropraxia was observed in the conventional group, which resolved within 6 weeks. No implant failure or need for secondary procedures was noted.

Functional outcomes assessed using Flynn's criteria showed excellent results in the majority of patients. In the conventional group, 91.2% had excellent outcomes, while in the Dorgan group, 97.1% achieved excellent outcomes. Cosmetic outcomes were excellent in 97.1% of cases in both groups.

Table 1: Demographic Distribution by Treatment Group (N = 68)

Variable	Category	Group I (Conventional) n=34	Group II (Dorgan) n=34	p-value
Age Group	4–8 years	18 (52.9%)	24 (70.6%)	0.134
	9–12 years	16 (47.1%)	10 (29.4%)	
Mean \pm SD	—	8.62 \pm 2.61	7.86 \pm 2.56	0.229
Sex	Male	21 (61.8%)	23 (67.6%)	0.612
	Female	13 (38.2%)	11 (32.4%)	

Table 2: Side Affected and Mechanism of Injury Distribution by Treatment Group (N = 68)

Variable	Category	Group I (Conventional) n=34	Group II (Dorgan) n=34	p-value
Side Affected	Left	18 (52.9%)	15 (44.1%)	0.467
	Right	16 (47.1%)	19 (55.9%)	
Mechanism of Injury	Fall from height	19 (55.9%)	15 (44.1%)	
	Bicycle accident	4 (11.8%)	7 (20.6%)	

	Game incident	6 (17.6%)	12 (35.3%)	
	Motor vehicle accident	5 (14.7%)	0 (0.0%)	0.04*

Statistically significant (p < 0.05)

There was no significant difference in side involvement between the two groups (p=0.467), indicating comparable laterality. However, the mechanism of injury differed significantly (p=0.04), with the conventional group showing more motor vehicle accidents, while the Dorgan group had relatively higher game-related injuries.

Table 3: Gartland Classification and Number of K-wires Distribution by Treatment Group (N = 68)

Variable	Category	Group I (Conventional) n=34	Group II (Dorgan) n=34	p-value
Gartland Classification	Type II	14 (41.2%)	15 (44.1%)	0.806
	Type III	20 (58.8%)	19 (55.9%)	
Number of K-wires	2 wires	12 (35.3%)	15 (44.1%)	0.457
	3 wires	22 (64.7%)	19 (55.9%)	

There was no statistically significant difference between the two groups in terms of fracture severity (Gartland classification) or number of K-wires used (p>0.05). This indicates that both treatment groups were comparable in fracture pattern and fixation requirements.

Table 4: Comparison of Operative Time, Union Time, and Range of Motion Between Treatment Groups (N = 68)

Variable (Mean ± SD)	Group I (Conventional) n=34	Group II (Dorgan) n=34	p-value
Procedure Time (min)	15.18 ± 4.11	24.24 ± 5.15	<0.001*
Union Time (weeks)	6.47 ± 0.66	6.44 ± 0.66	0.855
Flexion (degrees)	144.71 ± 7.28	144.85 ± 7.33	0.934
Pronation (degrees)	65.41 ± 3.74	70.88 ± 2.17	<0.001*
Supination (degrees)	71.18 ± 3.55	75.65 ± 1.94	<0.001*

Statistically significant (p < 0.05)

The conventional cross-pinning technique required significantly less operative time (p<0.001). However, union time was similar between groups (p=0.855). While flexion was comparable, the Dorgan technique showed significantly better pronation and supination (p<0.001), indicating superior rotational range of motion outcomes.

Table 5: Complications and Functional Outcome (Flynn's Criteria) by Treatment Group (N = 68)

Variable	Category	Group I (Conventional) n=34	Group II (Dorgan) n=34	p-value
Complications	Pin tract infection	1 (2.9%)	1 (2.9%)	1.000
	Stiffness	2 (5.9%)	1 (2.9%)	0.55
	Ulnar nerve injury	1 (2.9%)	0 (0.0%)	0.31
Functional Outcome (Flynn's criteria)	Excellent	31 (91.2%)	33 (97.1%)	
	Good	3 (8.8%)	1 (2.9%)	0.614

Table 6: Stiffness/Readmission and Cosmetic Outcome (Flynn's Criteria) by Treatment Group (N = 68)

Variable	Category	Group I (Conventional) n=34	Group II (Dorgan) n=34	p-value
Stiffness/Readmission	No	34 (100.0%)	34 (100.0%)	—
	Yes	0 (0.0%)	0 (0.0%)	—
Cosmetic Outcome (Flynn's criteria)	Excellent	33 (97.1%)	33 (97.1%)	
	Good	1 (2.9%)	1 (2.9%)	1.000

No patients in either group required readmission or physiotherapy for stiffness, indicating excellent postoperative recovery. Cosmetic outcomes were equally excellent in both groups (97.1%), with no statistically significant difference (p=1.000), demonstrating that both techniques provide comparable cosmetic results.

DISCUSSION

Supracondylar fractures of the humerus are among the most frequently encountered fractures in the pediatric population and continue to pose therapeutic challenges due to their potential for complications and long-term deformities (1,2). The primary goal of treatment is to achieve stable fixation with good functional and cosmetic outcomes while minimising complications such as malunion and nerve injury.

In the present study, the majority of patients were within the 4–8 years age group, with a mean age of 8.24 years, which is consistent with previous studies reporting peak incidence in younger children due to increased physical activity and

vulnerability of the distal humerus (3,4). There was a male predominance (64.7%), which aligns with earlier literature suggesting that boys are more prone to such injuries due to higher levels of outdoor activity (2,4).

The most common mechanism of injury in our study was a fall from height or fall on an outstretched hand, which is in agreement with findings by Farnsworth et al., who reported similar mechanisms in pediatric supracondylar fractures (4). Although a statistically significant difference in injury mechanism was observed between the two groups ($p=0.04$), this variation is unlikely to have influenced the overall outcomes significantly.

The distribution of fractures according to Gartland classification showed a predominance of Type III fractures, which is comparable to previous studies (6,7). Importantly, there was no significant difference between the two groups in terms of fracture type or number of K-wires used, indicating that both groups were comparable in baseline injury severity and fixation requirements.

One of the key findings of this study was that the operative time was significantly shorter in the conventional cross pinning group compared to the Dorgan technique ($p<0.001$). This may be attributed to the relative technical simplicity and familiarity of the conventional method. Similar observations have been reported in earlier studies where lateral-only techniques required more precise fluoroscopic guidance and technical expertise (11,15).

Despite the difference in operative time, fracture union time was comparable between both groups, with all fractures uniting within 6–8 weeks. This finding is consistent with previous literature, which suggests that both pinning techniques provide adequate stability for fracture healing (11,16).

In terms of functional outcomes, both techniques demonstrated excellent results. However, the Dorgan technique showed significantly better pronation and supination ($p<0.001$), indicating improved rotational range of motion. This may be due to less soft tissue disruption and avoidance of medial pin placement, thereby reducing postoperative stiffness. Similar findings have been reported by Kocher et al., who demonstrated satisfactory functional outcomes with lateral pinning techniques (16).

Flexion, however, was comparable between the two groups ($p=0.934$), indicating that both methods are equally effective in restoring sagittal plane motion. Overall, a near full range of motion was achieved in all patients by 6 months, which is in agreement with previous studies emphasising early mobilisation and stable fixation (7,11).

Complication rates in the present study were low and comparable between the two groups. Pin tract infection occurred in one patient in each group and was managed conservatively, which is consistent with reported rates in the literature (8,9). Ulnar nerve injury was observed in one case in the conventional cross-pinning group, which resolved spontaneously within 6 weeks. This supports previous reports highlighting the risk of ulnar nerve injury associated with medial pin insertion (13,14). Notably, no such injury was observed in the Dorgan group, reinforcing the safety advantage of lateral-only pinning techniques.

There were no cases of implant failure, loss of reduction, or need for reoperation, indicating that both techniques provide reliable fixation when performed correctly. Mild varus angulation was observed in two cases (one in each group), but it did not affect functional outcomes. This aligns with previous studies reporting occasional minor angular deformities without clinical significance (10).

Functional outcomes assessed using Flynn's criteria were excellent in the majority of cases, with 91.2% in the conventional group and 97.1% in the Dorgan group achieving excellent results. Cosmetic outcomes were also excellent in 97.1% of patients in both groups, with no significant difference. These findings are consistent with earlier studies demonstrating high success rates with both techniques (11,16,17).

Importantly, no patients required readmission or physiotherapy for stiffness, indicating effective rehabilitation and satisfactory recovery in both groups. This highlights the importance of proper surgical technique and postoperative care in achieving optimal outcomes.

Overall, the findings of this study suggest that while conventional cross pinning offers the advantage of shorter operative time, the Dorgan technique provides comparable stability with improved rotational movement and reduced risk of ulnar nerve injury. Both techniques yield excellent functional and cosmetic outcomes when appropriately applied.

CONCLUSION

Both conventional cross pinning and Dorgan's lateral cross pinning technique are effective and reliable methods for the management of displaced supracondylar humerus fractures in children, yielding excellent functional and cosmetic outcomes.

The conventional technique offers the advantage of shorter operative time, whereas the Dorgan technique provides comparable fracture stability with better rotational range of motion and reduced risk of ulnar nerve injury. Overall, Dorgan's technique may be preferred due to its safety profile, while both methods remain clinically acceptable with minimal complications and high success rates.

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