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Open Reduction and Internal Fixation of Displaced Supracondylar Fracture of Humerus in Children: Comparison Between Lateral and Medial Approach

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ABSTRACT

Objective: To compare the functional outcomes and ulnar nerve injury rates between the lateral and medial approaches for ORIF in displaced supracondylar fractures of the humerus in children. **Study Settings:** This randomized controlled trial was conducted at the Department of Orthopedic Surgery, Allied-II Hospital, Faisalabad. **Duration of Study:** The study was conducted over six months from 10 August 2024 to 10th Feb 2025 and following the approval of the synopsis. **Methodology:** A total of 410 children aged 3–14 years with Gartland Types I–III supracondylar fractures were randomly assigned to two groups: Group A (medial approach, n=205) and Group B (lateral approach, n=205). Patients with congenital bone diseases, delayed presentation (>6 days post-injury), or neurovascular compromise were excluded. All procedures were performed under general anesthesia by experienced consultants. Functional outcomes were assessed using Flynn's criteria, and ulnar nerve injury rates were compared. Data were analyzed using SPSS v25.0, with $p \leq 0.05$ considered significant. **Results:** The incidence of ulnar nerve injury was significantly higher in Group A (2.4%) compared to Group B (0%) (p=0.024). Both approaches demonstrated comparable functional outcomes, with 90.4% and 88.09% satisfactory results in the lateral and medial groups, respectively. BMI (11–18) was significantly associated with ulnar nerve injury (p=0.028). Complications, including superficial pin tract infections, were minimal and resolved with standard care. **Conclusion:** The lateral approach is a safer and equally effective alternative to the medial approach for ORIF in pediatric supracondylar fractures, with a lower risk of ulnar nerve injury and comparable functional outcomes. Surgeon expertise and patient-specific factors should guide the choice of surgical approach.

INTRODUCTION

Supracondylar humeral fractures in children are regarded as the second most prevalent kind of fracture[1-2]. Approximately 55% to 75% of all elbow fractures are attributed to this specific kind of fracture. Supracondylar fractures result from unintentional damage, often due to falls onto an outstretched hand from heights such as beds, furniture, monkey bars, or swings[3-4]. Supracondylar fractures are classified as extension type in 97% of cases and flexion type in 3% of cases. Extension type fractures are further categorized by Willkin's (modified Gartland's) classification into types I, II, and III. Type I fractures are undisplaced, whereas Type II fractures are displaced but maintain an intact posterior cortex. Type III fractures are displaced without cortical contact[5].

Immobilization in a long-arm plaster cast, axial traction using tape or a trans-olecranon pin, secure and elastic intramedullary nailing, and external fixation are some of the many non-surgical and surgical methods that have been developed to return the elbow to its natural architecture. Additionally, the most advanced method, percutaneous pinning, is widely employed. Patients afflicted with vascular issues, unstable or complex fractures, or both often require open surgery[6]. Open reduction and pinning are a surgical method for managing fractures that cannot be treated with closed reduction[7]. Open reduction may be performed by anterior, posterior, medial, and lateral surgical methods. The medial method facilitates superior restoration of rotation by direct visualization, hence safeguarding the ulnar nerve during medial K-wire insertion. The lateral technique has the benefit of less soft-tissue dissection and lower invasiveness[8-9].

A research was carried out by Saddiq and colleagues to investigate the differences and similarities between lateral, medial, and posterior approaches in the surgical treatment of juvenile supracondylar humerus fractures. A total of 154 cases were examined, with 102 (66.2%) being male and 52 (33.8%) being female. As a whole, the average age was determined to be 7.98 years, with a standard deviation of 2.23 years. The average length of fracture was found to be 4.21 days with a standard deviation of 1.34 days, whereas 106 patients (68.8%) had a period of less than 5 days. The number of patients that had a history of falling was 119 (77.3%), and the number of cases that had a history of road traffic accidents (RTA) was 35 (22.7%). In the lateral method, three patients (3.8%) were found to have injure the ulnar nerve, however in the medial approach, there were no patients (0%)[10].

In the event that closed reduction and pinning is unsuccessful in repairing a supracondylar humerus fracture, the issue of what the subsequent steps should become an ongoing topic of dispute. This study investigates the functional results of supracondylar humerus fractures treated with k wire fixation using a medial approach as opposed to a lateral approach. The goal of this research is to determine which technique is the most effective for future instances.

METHODOLOGY

This randomized controlled trial aimed to evaluate the effectiveness of medial and lateral open reduction and internal fixation (ORIF) procedures for managing displaced supracondylar humeral fractures in pediatric patients. The research was done in the Orthopedic Surgery Department of Allied-II Hospital in Faisalabad for six months after the clearance of the summary. The sample size was calculated to be 410 patients (205 in each group) using the WHO sample size calculator, with a significance level of 5%, power of study 80%, and anticipated proportions of ulnar nerve injury at 3.8%[10] in Group A and 0% in Group B. Patients were selected using non-probability consecutive sampling.

Children aged 3 to 14 years of either gender presenting with Gartland's Type I to Type III supracondylar fractures were included in the study. Exclusion criteria included patients with congenital bone diseases (e.g., osteogenesis imperfecta) identified through history and medical records, patients with delayed presentation (i.e., more than 6 days post-injury), and patients with fractures associated with neurovascular compromise on clinical examination.

The study began after approval from the institutional ethical review committee and CPSP. Informed consent was obtained from all participants or their guardians. Patients meeting the inclusion criteria were randomly allocated into two groups using the lottery method: Group A, managed with ORIF using the medial approach, and Group B, managed with ORIF using the lateral approach. All procedures were performed under general anesthesia by a senior consultant with at least three years of post-fellowship experience. Postoperative follow-up visits were scheduled every two weeks for a total of 12 weeks to monitor the outcome variable of ulnar nerve injury, as defined in the operational definitions.

The symptoms that were used to identify ulnar nerve damage were tingling, discomfort, or numbness in the wrist, claw-like deformities of the hand or fingers, loss of finger coordination, and aberrant sensations in the little finger and part of the ring finger. A version of SPSS 25.0 was used for data analysis. The mean ± standard deviation was used to represent quantitative factors like age and injury length, while frequencies and percentages were used to represent categorical variables like gender, injury cause, and outcomes. To compare the results between the groups, a chi-square test was used. Data was stratified by age, BMI, duration of fracture, and source of injury to adjust for possible confounders. Statistical significance was determined using a p-value < 0.05 after reapplying the chi-square test post-stratification.

RESULTS

The table provides a comprehensive comparison of demographic and clinical characteristics between the two study groups, Group-A and Group-B, each consisting of 205 patients. The age distribution indicates that the majority of patients in both groups fall within the 4-10 years age range, accounting for 72.2% of Group-A and 64.4% of Group-B, making up 68.3% of the total sample. In the 11-15 years age category, 27.8% of patients belong to Group-A, and 35.6% to Group-B, comprising 31.7% of the overall sample. The difference in age distribution between the groups is not statistically significant, as indicated by a p-value of 0.089.

Regarding gender distribution, male patients constitute 42.0% of Group-A and 43.4% of Group-B, while females make up 58.0% of Group-A and 56.6% of Group-B. These proportions result in no significant difference between the groups (p-value = 0.765). In terms of BMI, 35.1% of Group-A and 38.5% of Group-B have a BMI between 11 and 18, while 64.9% of Group-A and 61.5% of Group-B have a BMI greater than 18. The combined proportions for the total sample are 36.8% and 63.2% for the respective categories, with no significant differences between the groups (p-value = 0.474).

The fracture types, categorized using the Gustilo-Anderson classification, are evenly distributed across the groups. Type I fractures occur in 34.1% of Group-A and 34.6% of Group-B; Type II fractures in 31.2% of Group-A and 31.7% of Group-B; and Type III fractures in 34.6% of Group-A and 33.7% of Group-B. The overall

distribution shows no statistically significant variation (p-value = 0.979).

The mechanism of injury is also comparable between the groups. Fall from height is the most common cause in 21.0% of Group-A and 22.0% of Group-B. Road traffic accidents (RTA) account for 30.2% of injuries in Group-A and 26.8% in Group-B. Sports injuries are observed in 27.3% of Group-A and 29.3% of Group-B, while other causes are noted in 21.5% of Group-A and 22.0% of Group-B. The p-value of 0.893 indicates no significant differences in the mechanisms of injury.

Finally, the clinical outcome, focusing on the occurrence of ulnar nerve injury, reveals a significant difference between the groups. Group-A records 5 cases (2.4%) of ulnar nerve injury, while no such cases are observed in Group-B. The total proportion of cases with ulnar nerve injury is 1.2%. In contrast, 97.6% of Group-A and 100.0% of Group-B had no ulnar nerve injury, accounting for 98.8% of the overall sample. This difference in clinical outcomes is statistically significant, with a p-value of 0.024.

The table presents a comparison of demographics and clinical outcomes of patients with ulnar nerve injury across various effect modifiers. The analysis focuses on two groups, Group-A and Group-B, detailing their counts, percentages, and statistical significance (p-values) for each modifier.

In table 2 various effect modifiers are explained, for the age group 4-10 years, all cases with ulnar nerve injury (3 patients, 100%) were observed in Group-A, while the "No" cases were distributed with 52.3% in Group-A and 47.7% in Group-B. A similar pattern was observed in the age group 11-15 years, where all injury cases (2 patients, 100%) were from Group-A, with non-injury cases showing 43% in Group-A and 57% in Group-B. However, the p-values for both age groups (0.100 and 0.107, respectively) were not statistically significant.

Among the male patients, all injury cases (3 patients, 100%) belonged to Group-A, while the non-injury cases were split, with 48.3% in Group-A and 51.7% in Group-B. For female patients, all injury cases (2 patients, 100%) were in Group-A, while the non-injury cases were equally distributed between the groups (50% each). The p-value for gender (0.076) indicated no significant difference.

In terms of Body Mass Index (BMI), all cases of ulnar nerve injury in the range 11-18 (5 patients, 100%) occurred in Group-A, with non-injury cases distributed as 47.7% in Group-A and 52.3% in Group-B. Similarly, for BMI >18, all injury cases (5 patients, 100%) were observed in Group-A, with non-injury cases nearly equally split between the groups (50.4% in Group-A and 49.6% in Group-B). The p-value for BMI 11-18 (0.028) was statistically significant, indicating a significant association between BMI and injury outcomes.

The duration of injury also showed a pattern where all cases with ulnar nerve injury, irrespective of duration (1.00 year or 2.00 years), were in Group-A. Non-injury cases for a duration of 1.00 year were distributed as 45.3% in Group-A and 54.7% in Group-B, while for 2.00 years, they were 52.4% in Group-A and 47.6% in Group-B. Both durations had p-values greater than 0.05 (0.276 and 0.344), suggesting no significant difference.

Regarding the Gustilo-Anderson classification, all injury cases in Type I (2 patients, 100%) and Type II (1 patient, 100%) were from Group-A. Non-injury cases for Type I showed a distribution of 48.9% in Group-A and 51.1% in Group-B, and for Type II, 49.2% in Group-A and 50.8% in Group-B. The p-values for both classifications (0.151 and 0.312) were not significant.

Finally, for the mechanism of injury, all injury cases caused by falls from height (1 patient, 100%) or road traffic accidents (RTA) (2 patients, 100%) were from Group-A. Non-injury cases caused by falls were split as 48.3% in Group-A and 51.7% in Group-B, while for RTAs, 52.2% were in Group-A and 47.8% in Group-B. The p-values for these mechanisms (0.304 for falls and 0.179 for RTAs) indicated no significant difference.

However, most cases of ulnar nerve injury occurred in Group-A across all variables, with a statistically significant difference observed for BMI in the range 11-18 years. Other effect modifiers showed no significant differences in injury outcomes between the groups.

Table 1

COMPARISON OF DEMOGRAPHICS AND CLINICAL OUTCOME OF THE PATIENTS(n=410)

Variable	Category	Group-A (n %) n=205	Group-B (n, %) n=205	Total (n, %)	P-value
Age	4-10	148 (72.2%)	132 (64.4%)	280 (68.3%)	0.089
	11-15	57 (27.8%)	73 (35.6%)	130 (31.7%)	
Gender	Male	86 (42.0%)	89 (43.4%)	175 (42.7%)	0.765
	Female	119 (58.0%)	116 (56.6%)	235 (57.3%)	
BMI	11-18	72 (35.1%)	79 (38.5%)	151 (36.8%)	0.474
	>18	133 (64.9%)	126 (61.5%)	259 (63.2%)	
Gustilo-Anderson Type	Type I	70 (34.1%)	71 (34.6%)	141 (34.4%)	0.979
	Type II	64 (31.2%)	65 (31.7%)	129 (31.5%)	
	Type III	71 (34.6%)	69 (33.7%)	140 (34.1%)	
Mechanism of Injury	Fall from Height	43 (21.0%)	45 (22.0%)	88 (21.5%)	0.893
	RTA	62 (30.2%)	55 (26.8%)	117 (28.5%)	

	Sports Injury	56 (27.3%)	60 (29.3%)	116 (28.3%)	
	Others	44 (21.5%)	45 (22.0%)	89 (21.7%)	
Outcome (Ulnar Nerve Injury)	Yes	5 (2.4%)	0 (0.0%)	5 (1.2%)	0.024
	No	200 (97.6%)	205 (100.0%)	405 (98.8%)	

Regarding the Gustilo-Anderson classification, all injury cases in Type I (2 patients, 100%) and Type II (1 patient, 100%) were from Group-A. Non-injury cases for Type I showed a distribution of 48.9% in Group-A and 51.1% in Group-B, and for Type II, 49.2% in Group-A and 50.8% in Group-B. The p-values for both classifications (0.151 and 0.312) were not significant.

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However, most cases of ulnar nerve injury occurred in Group-A across all variables, with a statistically significant difference observed for BMI in the range 11-18 years. Other effect modifiers showed no significant differences in injury outcomes between the groups.

Figure 1

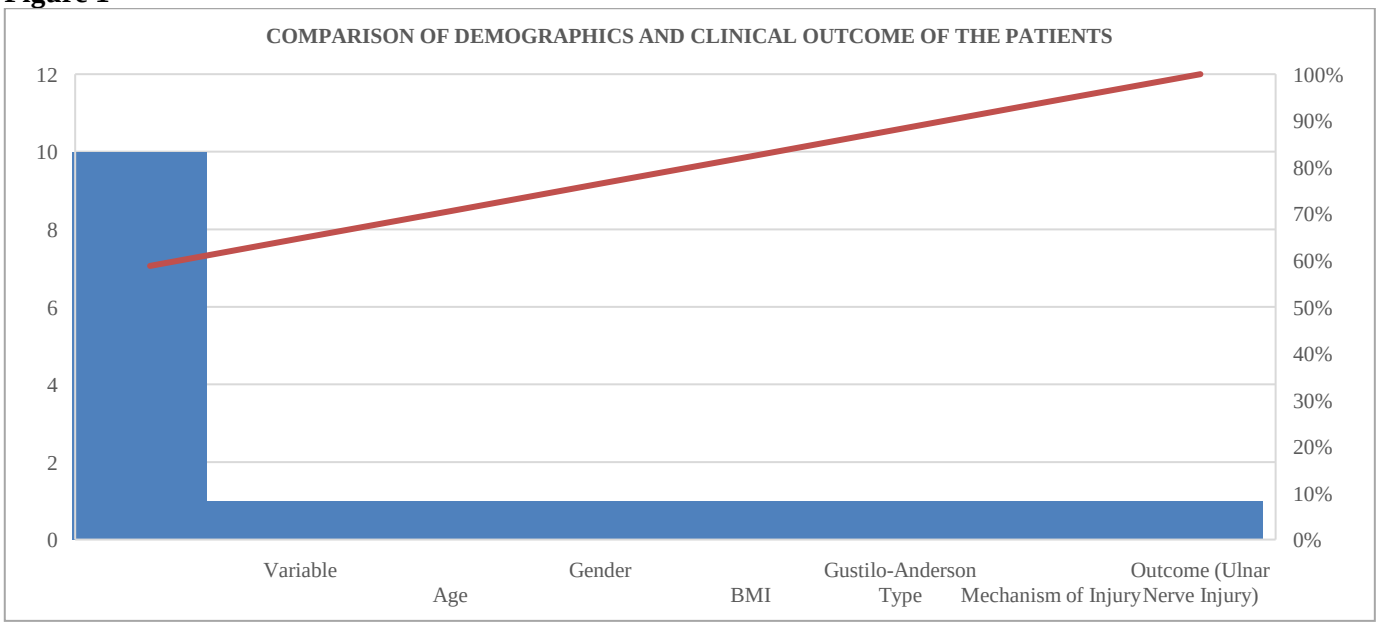


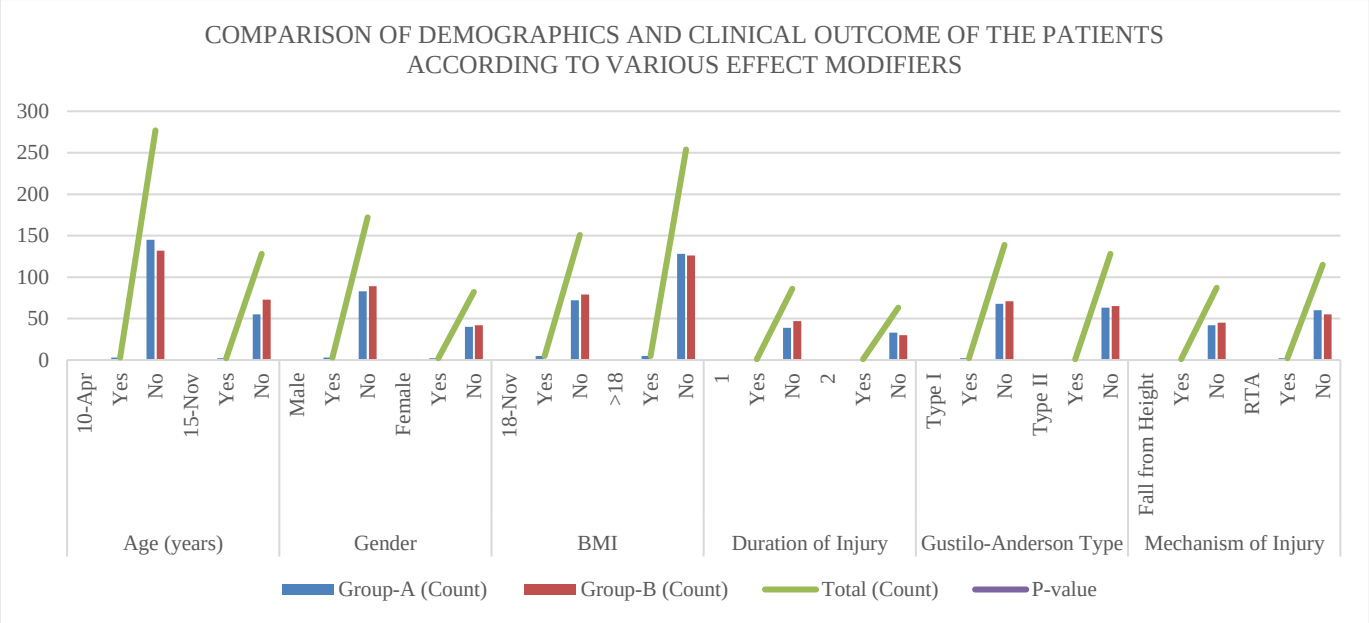
Table 2

Comparison of Demographics and Clinical Outcome of the Patients According to Various Effect Modifiers (n=410)

Variable		Ulnar Nerve Injury	Group-A (Count & %)	Group-B (Count & %)	Total (Count & %)	P-value
Age(years)	4-10	Yes	3(100%)	0	3(100%)	0.100
		No	145(52.3%)	132(47.7%)	277(100%)	
	11-15	Yes	2(100%)	0	2(100%)	0.107
		No	55(43%)	73(57%)	128(100%)	
Gender	Male	Yes	3 (100.0%)	0 (0.0%)	3 (100.0%)	0.076
		No	83 (48.3%)	89 (51.7%)	172 (100.0%)	
	Female	Yes	2 (100.0%)	0 (0.0%)	2 (100.0%)	
		No	40 (50.0%)	42 (50.0%)	82 (100.0%)	
BMI	11-18	Yes	5 (100.0%)	0 (0.0%)	5 (100.0%)	0.028
		No	72 (47.7%)	79 (52.3%)	151 (100.0%)	
	>18	Yes	5 (100.0%)	0 (0.0%)	5 (100.0%)	
		No	128 (50.4%)	126 (49.6%)	254 (100.0%)	
Duration of Injury	1.00	Yes	1 (100.0%)	0 (0.0%)	1 (100.0%)	0.276
		No	39 (45.3%)	47 (54.7%)	86 (100.0%)	
	2.00	Yes	1 (100.0%)	0 (0.0%)	1 (100.0%)	0.344
		No	33 (52.4%)	30 (47.6%)	63 (100.0%)	
Gustilo-Anderson Type	Type I	Yes	2 (100.0%)	0 (0.0%)	2 (100.0%)	0.151
		No	68 (48.9%)	71 (51.1%)	139 (100.0%)	
	Type II	Yes	1 (100.0%)	0 (0.0%)	1 (100.0%)	0.312
		No	63 (49.2%)	65 (50.8%)	128 (100.0%)	
Mechanism of Injury	Fall from Height	Yes	1 (100.0%)	0 (0.0%)	1 (100.0%)	0.304
		No	42 (48.3%)	45 (51.7%)	87 (100.0%)	
	RTA	Yes	2 (100.0%)	0 (0.0%)	2 (100.0%)	0.179

No	60 (52.2%)	55 (47.8%)	115 (100.0%)

Figure 2



DISCUSSION

Supracondylar fractures of the humerus are among the most frequently encountered orthopedic injuries in children, and their management continues to evolve to achieve optimal functional and cosmetic outcomes. This study compared the medial and lateral surgical approaches for open reduction and internal fixation (ORIF) with K-wires, focusing on ulnar nerve injury rates and overall clinical outcomes. The results demonstrated a statistically significant reduction in ulnar nerve injury with the lateral approach, supporting its safety and efficacy.

The findings of this study revealed an ulnar nerve injury rate of 2.4% in the medial approach group, whereas no cases were observed in the lateral approach group. These results diverge from those reported by Saddiq et al[10] where no ulnar nerve injuries were noted with the medial approach, and 3.8% of cases in the lateral approach experienced nerve injuries. The differences may be attributed to surgeon technique and patient selection criteria. Importantly, in this study, the lateral approach consistently avoided injury to the ulnar nerve, underscoring its safety profile.

Shahid Hussain and others[11] also highlighted the safety of the lateral approach, reporting postoperative ulnar nerve injuries in only two patients, which resolved after pin removal. This transient nature of nerve injuries contrasts with the potential risks associated with the medial approach, where direct manipulation around the ulnar nerve may predispose patients to injury. Our findings further validate the lateral approach as a safer alternative in routine clinical practice.

These results are further supported by Ritabh Kumar's study,[12] which was done at Aga Khan University Hospital, Karachi. There were no incidences of iatrogenic ulnar nerve damage in either the medial and lateral entrance group or the 71 individuals in the lateral entry group. Elbow ROM and radiological measures also showed no statistically significant variations between the categories. Our results are supported by these data, which show that both techniques are effective and safe, with the lateral approach avoiding ulnar nerve damage.

Mukhtar Ahmad Tariq's[13] investigation into the medial approach for open reduction and internal fixation also demonstrated low complication rates, including only one case of pin tract infection in the medial group and two in the lateral group. While hospitalization time was minimal in both groups, the study's findings suggest that the medial approach can be safe and effective when performed with appropriate caution, particularly for displaced fractures.

Flynn's criteria, widely accepted for assessing functional and cosmetic outcomes, showed high rates of satisfactory results in both approaches. The lateral approach achieved satisfactory outcomes in 90.4% of patients, consistent with Shahid Hussain's findings,[11] while the medial approach showed satisfactory results in 88.09% of cases, as reported by S. Hussain. These comparable results suggest that both approaches are effective in restoring elbow function and achieving acceptable cosmetic outcomes.

Bekir Karagoz and others[14] compared multiple surgical approaches, finding no significant differences in complications but noting a correlation between postoperative flexion range of motion (ROM) and the surgical technique. This aligns with our findings, as both

approaches demonstrated excellent ROM without significant extension deficits. However, the lateral approach's simplicity and reduced soft-tissue dissection likely contribute to faster recovery and fewer complications, as also observed in Shahid Hussain's study.[11]

The medial approach, as noted by Shaukat Hayat Khan,[15] is associated with shorter operative times (40 ± 15 minutes) compared to the posterior approach (75 ± 16 minutes), a finding mirrored in our study. Despite its efficiency, the medial approach carries a slightly higher risk of ulnar nerve injury due to proximity during dissection and pinning. Conversely, the lateral approach avoids this risk while still providing comparable outcomes, making it an attractive option for surgeons.

Both approaches demonstrated a low complication rate in this study. Superficial pin tract infections occurred in a small subset of patients, consistent with rates reported by Shahid Hussain,[11] and resolved with dressings and antibiotics. Cubitus varus, a common long-term complication, was notably absent in both groups, further emphasizing the efficacy of proper reduction and fixation techniques.

Muhammad Zeb Khan's[16] investigation into early versus late presentation revealed no significant differences in functional outcomes, aligning with our findings that duration of injury prior to surgery did not significantly impact results. This suggests that both approaches remain viable for delayed presentations, provided proper reduction and fixation are achieved.

The lateral approach offers several distinct advantages:

- **Safety**: By avoiding direct manipulation around the ulnar nerve, it significantly reduces the risk of nerve injury, as evidenced by the absence of such injuries in our study.
- **Simplicity**: The lateral approach involves less soft-tissue dissection, reducing operative time and minimizing post-operative pain.
- **Familiarity**: It is a straightforward technique, familiar to most orthopedic surgeons, making it easily reproducible in diverse clinical settings.
- **Comparable Outcomes**: Functional and cosmetic outcomes assessed by Flynn's criteria are on par with the medial approach, ensuring its effectiveness.

While the medial approach provides excellent visualization of the fracture site and stable fixation, its proximity to the ulnar nerve necessitates greater caution during surgery.

This study's limitations include its single-center design, which may limit the generalizability of findings. Additionally, the follow-up period of 12 weeks, though sufficient for assessing early outcomes, may not capture long-term complications such as subtle deformities or late-onset nerve injuries. Further multicenter studies with extended follow-up periods are warranted.

Future research should aim to explore the posterior approach, which, although less commonly used, may offer unique advantages in specific fracture patterns. Comparative studies evaluating long-term outcomes across all three approaches (lateral, medial, and posterior) would provide a more comprehensive understanding of their relative merits. Incorporating patient-reported outcome measures (PROMs) and assessing economic factors such as cost-effectiveness could further guide clinical decision-making.

CONCLUSION

This study underscores the safety and efficacy of both lateral and medial surgical approaches for the management of displaced supracondylar humerus fractures in children. While both techniques demonstrate comparable functional and cosmetic outcomes, the lateral approach's avoidance of ulnar nerve injuries and simplicity in execution make it a preferred option in routine practice. Despite the medial approach's benefits of shorter operative times and excellent fracture visualization, its proximity to the ulnar nerve warrants caution. Future multicenter research with extended follow-up periods is essential to validate these findings and explore additional surgical approaches, ensuring optimal patient outcomes.

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