

RESEARCH ARTICLE

Anterior Versus Posterior Surgical Approaches to Pediatric Supracondylar Humerus Fracture

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Received: 5 January 2024

Accepted: 18 July 2024

Abstract

Objectives: Gartland type III supracondylar humerus fractures frequently occur as traumatic injuries in children and often require surgical intervention. This study aimed to compare the efficacy of anterior and posterior surgical approaches to treating these fractures.

Methods: This retrospective study analyzed 48 patients under the age of 10 with Gartland type III fractures. These patients were treated with either the anterior (n=23) or the posterior approach (n=25). At three and six months post-surgery, elbow range of motion (ROM), complications, and functional/cosmetic outcomes were assessed using Flynn's criteria.

Results: No significant differences were found between the groups regarding age or gender. At three months, the anterior group showed significantly better extension (-8.26° vs. -13.20° , $P=0.032$), but this difference was not significant at six months. No significant differences were observed in flexion, pronation, or supination at any time point. Both groups showed significant ROM improvements from three to six months ($P<0.001$); however, these improvements were slightly below the normative values ($P<0.05$). The overall complication rates were low and comparable between the two approaches (anterior: 8.70%; posterior: 12.00%; $P=0.700$), primarily comprising reversible ulnar nerve injuries and superficial infections. Furthermore, based on Flynn's criteria, there were no significant differences in functional or cosmetic outcomes, with most patients achieving excellent or good results in both groups.

Conclusion: Both anterior and posterior approaches for pediatric Gartland type III supracondylar humerus fractures resulted in satisfactory outcomes. Therefore, the choice of surgical approach will depend on patient-related factors and surgeons' preferences.

Level of evidence: III

Keywords: Anterior approach, Elbow range of motion, Pediatric orthopedics, Posterior approach, Supracondylar humerus fracture, Surgical outcomes

Introduction

Supracondylar humerus fractures are among the most prevalent traumatic injuries in children, predominantly affecting those aged 5-10 years.^{1,2} These fractures are most commonly observed following a fall on an outstretched hand in an extended position. Notably, 95-98% of these fractures are of the extension type, with the flexion type accounting for less than 5%.^{3,4} Supracondylar humerus fractures in children are categorized using the Gartland classification, which

includes type I (non-displaced), type II (hinged with intact posterior cortex), and type III (completely displaced) fractures.^{5,6} These fractures account for over 80% of all elbow fractures in children, making their management crucial.⁷

Noninvasive treatment is often preferred in the management of fractures in children.⁸ Specifically, the recommended treatment for supracondylar humeral fractures involves closed reduction and percutaneous

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Kirschner (K)-wire fixation.⁹ Furthermore, vessel exploration is necessary only if the distal pulses are absent.¹⁰ In addition, primary nerve exploration is not required unless there is a complete primary sensorimotor nerve lesion.^{9,11} However, supracondylar humeral fractures are often classified as Gartland type III fractures of the extension type, which typically require surgical intervention. It is worth noting that this type of fracture is common in children's elbow injuries, accounting for up to two-thirds of all pediatric elbow injuries that require hospitalization.^{12,13}

The choice of surgical approach for supracondylar fractures remains controversial among orthopedic specialists. The two main procedures, anterior and posterior, have distinct advantages and disadvantages. Research indicates that the anterior approach reduces complications due to better surgical exposure, facilitates precise reduction and fixation, and allows access to neurovascular structures to manage potential issues, such as vascular injuries.^{14,15} Some studies, on the other hand, support the posterior approach for its ease of access and better fracture site visualization. This method offers secure fracture reduction and shorter operating times but may limit elbow range of motion (ROM).^{16,17}

Due to the ongoing debates surrounding the merits of anterior and posterior surgical interventions in the management of supracondylar fractures in children, this study presents a comprehensive evaluation of the two approaches. More specifically, this study aims to compare the treatment efficacy of anterior and posterior surgical approaches for Gartland type III supracondylar humerus fractures in children in terms of clinical outcomes, such as ROM, postoperative complications, and more comprehensive parameters, such as patient satisfaction and overall recovery experience.

Materials and Methods

Study Design and Setting

This retrospective study evaluated the surgical outcomes of anterior versus posterior approaches for pediatric Gartland type III supracondylar humerus fractures. The study was conducted at the orthopedic centers of Kashani Hospital, Isfahan, Iran, between August and December 2020, following approval by the Institutional Review Board of Isfahan University of Medical Sciences, Isfahan, Iran (Approval ID: IR.MUI.MED.REC.1400.464).

Participants

A census sampling method was employed to enroll patients under the age of 10 with Gartland type III supracondylar humerus fractures admitted during the study period. The exclusion criteria included patients with open fractures, neurovascular injuries, flexion-type fractures, or previous fractures of the same extremity. The study ultimately included 48 patients who required open reduction after unsuccessful closed reduction attempts via either the anterior or posterior approach. Informed consent was obtained from all guardians.

Surgical Procedures

All surgical procedures were performed by two experienced pediatric orthopedic surgeons. The choice of surgical approach (anterior or posterior) was based on the

surgeon's clinical judgment, considering factors such as the specifics of the fracture and potential complications.

The procedures involved the use of pneumatic tourniquets and general anesthesia, with initial attempts at closed reduction. For the anterior group, the Henry approach was employed, involving a 3-4 cm incision above and parallel to the antecubital fossa, identification and management of the neurovascular bundle, and stripping of the periosteum between the brachialis and brachioradialis muscles, with the utmost care taken to protect the radial nerve.

In the posterior (triceps-sparing) group, careful attention was paid to avoiding ulnar nerve injuries. The hematoma was meticulously removed, and the synovial tissue surrounding the triceps tendon was carefully excised from both the medial and lateral aspects while preserving the extensor mechanism. The fracture lines and fragments were precisely realigned.

In both surgical techniques, a standardized approach was ensured by inserting two or three K-wires from the lateral column. After the pins were placed, surgeons evaluated the ROM of the elbow and assessed the pin placement, fracture stability, and alignment using intraoperative fluoroscopy. If the fixation was not sufficiently stable, K-wires were added from the medial side to ensure adequate stabilization.

Postoperative Care and Follow-Up

Following surgery, all patients received a splint to keep their elbows flexed at approximately 90°. A radiologist and two independent orthopedic specialists who were not involved in the surgery conducted follow-up assessments at 7-10 days, 1 month, 3 months, and 6 months after the procedure.

Upon radiographic confirmation of fracture healing, the splint and K-wires were removed approximately four weeks post-surgery, and patients were advised to start elbow ROM exercises.

Outcome Measures

The primary outcome was to evaluate the efficacy of the anterior and posterior surgical approaches by comparing elbow ROM at three and six months postoperatively. ROM was assessed using a standardized goniometer. Measurements included flexion and extension (with the goniometer centered at the lateral epicondyle, one arm aligned with the humerus, and the other with the forearm), as well as supination and pronation (with the elbow flexed to 90°, one arm aligned with the humerus, and the other with the radial styloid process).

The secondary outcomes included the evaluation of functional and cosmetic results using Flynn's criteria at the final follow-up. The incidence of complications, such as infection, nerve injury, cubitus varus/valgus, osteonecrosis, compartment syndrome, and malunion, was assessed at each follow-up visit.

Flynn's criteria evaluated loss of elbow motion and changes in carrying angle relative to the uninjured side. Loss of motion and changes in the carrying angle were categorized as excellent (<5°), good (5-10°), fair (11-15°), or poor (>15°).

Statistical Analysis

Data analysis was performed using SPSS software (version 24). Descriptive statistics were used to summarize the demographic and clinical characteristics of the participants, including the means, standard deviations, and counts. The normality of the data distribution was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Between-group comparisons were conducted using an independent t-test for normally distributed variables, such as age. For non-normally distributed variables, such as elbow range of motion (ROM) over time, the Wilcoxon signed-rank test was used for within-group comparisons and the Mann-Whitney U test for between-group comparisons. Categorical data were analyzed using the Chi-squared test and Fisher's exact test. One-sample t-tests were used to compare the three- and six-month outcomes to the normative values for elbow ROM. The statistical significance level was set at $P < 0.05$.

Results

Demographic and Cohort Characteristics

This study included 48 patients with supracondylar humeral fractures. The group that underwent the anterior approach ($n=23$) had an average age of 5.61 ± 2.02 years, while the group that received the posterior approach ($n=25$) had an average age of 4.60 ± 1.53 years. The results of an independent t-test revealed no significant difference in age between the two groups ($P=0.063$). In the anterior group, 34.78% were female ($n=8$) and 65.22% were male ($n=15$). In the posterior group, 28.00% were female ($n=7$), and 72.00% were male ($n=18$). A Chi-squared test indicated no significant difference in gender distribution between the two groups ($P=0.573$). The cohort comprised 33 males and 15 females, with an average age of 5.08 ± 1.83 years.

Elbow Range of Motion Outcomes

Flexion

At three months postoperatively, both the anterior and posterior groups exhibited similar mean elbow flexion, with measurements of $121.74 \pm 9.955^\circ$ and $123.00 \pm 7.638^\circ$, respectively. The Mann-Whitney U test revealed no significant differences between the two groups ($P=0.701$). At six months, both groups experienced a slight improvement in

elbow flexion, with the anterior and posterior groups measuring $137.61 \pm 4.229^\circ$ and $138.20 \pm 3.786^\circ$, respectively. However, the difference between the two groups remained statistically insignificant ($P=0.734$).

Extension

At three months postoperatively, the anterior group had a mean extension of $-8.26 \pm 8.341^\circ$, whereas the posterior group had a mean extension of $-13.20 \pm 8.021^\circ$. By six months, both groups showed improvement: the anterior group showed an extension deficit of $-2.17 \pm 4.217^\circ$, and the posterior group demonstrated an extension deficit of $-4.40 \pm 5.066^\circ$. At the three-month follow-up, the anterior injury group displayed a significantly smaller extension deficit compared to the posterior injury group (-8.26 vs. -13.20° , $P=0.032$). However, by six months, both groups had improved, and the difference was no longer statistically significant ($P=0.106$).

Supination

At three months postoperatively, the mean supination angle in the anterior group was $71.30 \pm 8.423^\circ$, whereas that in the posterior group was $67.20 \pm 6.934^\circ$. By six months, these values had increased to $81.30 \pm 4.322^\circ$ and $78.40 \pm 5.723^\circ$ for the anterior and posterior groups, respectively. However, there was no significant difference in supination between the two groups at either three months ($P=0.067$) or six months ($P=0.072$).

Pronation

At three months, patients in the anterior group had an average pronation of $66.30 \pm 5.049^\circ$, whereas those in the posterior group had an average pronation of $67.20 \pm 7.083^\circ$. By six months, pronation increased to an average of $76.52 \pm 4.111^\circ$ in the anterior group and an average of $76.80 \pm 4.537^\circ$ in the posterior group. However, the statistical analysis showed no significant difference in pronation between the two groups either at three months ($P=0.438$) or six months ($P=0.687$) postoperatively.

The postoperative outcomes of elbow flexion, extension, supination, and pronation at three and six months are summarized in [Table 1].

Table 1. Elbow ROM at three and six months post-surgery

Measurement	3 m Anterior Mean \pm SD	3 m Posterior Mean \pm SD	P-Value	6 m Anterior Mean \pm SD	6 m Posterior Mean \pm SD	P-Value
Flexion	121.74 \pm 9.955	123.00 \pm 7.638	0.701	137.61 \pm 4.229	138.20 \pm 3.786	0.734
Extension	-8.26 \pm 8.341	-13.20 \pm 8.021	0.032*	-2.17 \pm 4.217	-4.40 \pm 5.066	0.106
Pronation	66.30 \pm 5.049	67.20 \pm 7.083	0.438	76.52 \pm 4.111	76.80 \pm 4.537	0.687
Supination	71.30 \pm 8.423	67.20 \pm 6.934	0.067	81.30 \pm 4.322	78.40 \pm 5.723	0.072

*A statistically significant difference ($P < 0.05$)

Comparisons to Normal Values

Based on the results of the Wilcoxon signed-rank test, both the anterior and posterior groups demonstrated significant improvements in all four ROM measurements (flexion,

extension, pronation, and supination) from three to six months ($P < 0.001$ for all comparisons). However, when compared to the established normative values using one-

sample t-tests,¹⁸⁻²⁰ both surgical approaches experienced a slight but statistically significant reduction in elbow ROM at both three and six months postoperatively ($P < 0.05$ for all comparisons) [Error! Reference source not found.]. These

results indicate that, although improvements were observed over time, neither group fully restored elbow ROM to normative levels during the postoperative period.

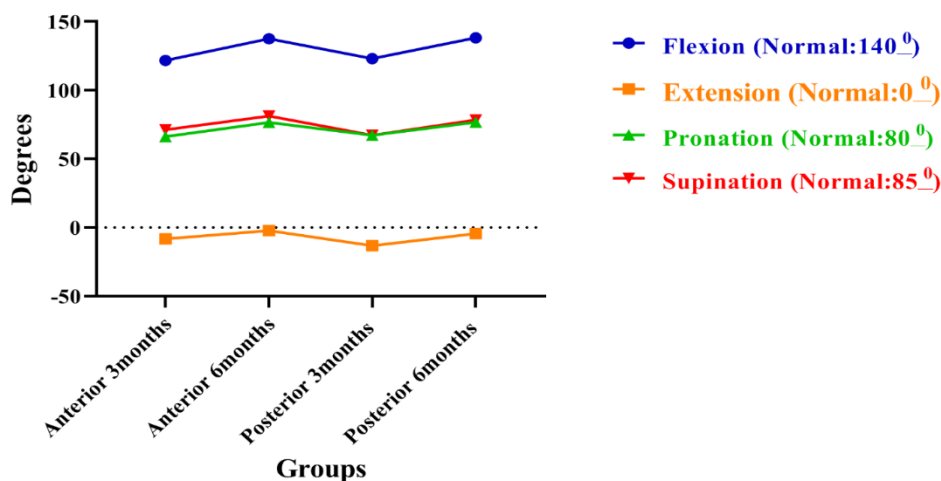


Figure 1. Elbow ROM outcomes compared to normative values. Both anterior and posterior surgical approach groups improved from three to six months but remained slightly below normative values at both time points

Complications

According to Fisher's exact test, complication rates were 8.70% (2 of 23) in the anterior group and 12.00% (3 of 25) in the posterior group, with no statistically significant difference ($P = 0.700$). Three patients experienced ulnar nerve injuries: two from the posterior group and one from the anterior group. Notably, one patient with medial pin placement showed signs of ulnar nerve damage during the immediate postoperative neurovascular examination. This patient was promptly re-operated on, with the medial pin removed and a long-arm cast applied for stabilization. Fortunately, all three patients with nerve injuries recovered during the follow-up period. In addition, one patient from each surgical group developed a superficial surgical site infection, which was effectively managed with antibiotic

therapy during the follow-up.

Functional and Cosmetic Outcomes

Flynn's criteria were used to evaluate functional and cosmetic outcomes. The anterior approach yielded excellent results of 65.22% and 34.78% for functional and cosmetic outcomes, respectively, whereas the posterior approach yielded excellent results of 56.00% and 44.00%, respectively. Cosmetic outcomes for the anterior approach were categorized as excellent (60.87%), good (39.13%), excellent (56.00%), good (40.00%), and fair (4.00%). Chi-squared tests revealed no statistically significant differences in the functional and cosmetic outcomes between the two groups [Table 2]. Overall, both surgical approaches provided satisfactory functional and cosmetic outcomes.

Table 2. Comparison of functional and cosmetic outcomes between anterior and posterior approaches using Flynn's criteria

Outcome	Group	Excellent	Good	Fair	Poor	P-value
Functional	Anterior	15 (65.22%)	8 (34.78%)	0 (0%)	0 (0%)	0.319
	Posterior	14 (56.00%)	11 (44.00%)	0 (0%)	0 (0%)	
Cosmetic	Anterior	14 (60.87%)	9 (39.13%)	0 (0%)	0 (0%)	0.814
	Posterior	14 (56.00%)	10 (40.00%)	1 (4.00%)	0 (0%)	

Discussion

The present study investigated the effects of anterior and posterior surgical procedures on supracondylar humeral fractures in children. This study found that both techniques resulted in similar outcomes in elbow flexion, extension, supination, and pronation. Although there were slight differences in extension at three months, these differences

were no longer present at six months. Our study revealed that patients in both surgical groups demonstrated significant improvements in elbow ROM (flexion, extension, supination, and pronation) between the three- and six-month follow-up periods. However, their elbow ROM remained slightly below normative values during this time frame, and this difference was statistically significant.

Flynn's criteria yielded satisfactory results for both anterior and posterior approaches, showing no statistically significant differences. The anterior approach resulted in 65.22% excellent and 34.78% good functional outcomes, whereas the posterior approach had 56.00% excellent and 44.00% good outcomes. Cosmetic outcomes were also favorable, with most patients in both groups achieving excellent or good ratings. These findings are consistent with those of previous research, indicating that both approaches can produce satisfactory functional and cosmetic outcomes when used appropriately.^{21,22} The incidence of complications was relatively low, with only a few reported cases of ulnar nerve injuries and superficial surgical site infections.

These results are consistent with recent research, including studies from 2023, which have significantly influenced surgical decision-making and patient care.^{22,23} Our findings are consistent with previous studies, suggesting that the anterior approach often leads to better functional outcomes and fewer complications.^{24,25} The superior functional outcomes associated with the anterior approach can be attributed to its surgical exposure, which facilitates precise identification of anatomic structures and promotes safety while minimizing complication rates.²⁵

Conversely, studies advocating for the posterior approach, such as those by Türkmen et al.,²⁶ emphasized the merits of easier fracture reduction and shorter operating time, especially in cases where early closed reduction and percutaneous pinning are challenging. Research comparing the anterior and posterior approaches for fracture treatment suggests that although the anterior approach is more intricate, it produces superior long-term outcomes. In contrast, the posterior approach offers easier execution and improved visualization of the fracture site. The anterior approach is generally recommended for grade II fractures, while the posterior approach may be more appropriate for severely displaced Gartland type III fractures or situations where comminution complicates percutaneous pinning, particularly affecting the medial or lateral condyle.²⁷

Both groups showed deviations from normal ROM values, indicating potential restrictions in elbow function. This highlights the critical role of postoperative rehabilitation and physiotherapy in enhancing functional recovery in patients with supracondylar humeral fractures.²⁸ Although these deficits were statistically significant, their clinical implications and long-term impact on patient outcomes are not fully understood. Therefore, future studies with extended follow-up periods are needed to clarify the functional impact of these ROM deficits and to develop targeted rehabilitation strategies to optimize patient recovery.^{29,30}

Fatah et al.²⁷ showed an infection rate of 4.1% for a single case in each group. In contrast, Ersan et al.³¹ found a 6% infection rate in two cases. One patient who developed iatrogenic ulnar nerve palsy was treated using the anterior approach and recovered nine weeks post-surgery. Additionally, a single case of radial nerve injury has been reported. It is evident from the postoperative care period that patients with supracondylar humerus fractures made

significant strides toward recovery, indicating the efficacy of our management strategy. Importantly, there were no complications, such as pin migration, cubitus varus/valgus, or osteonecrosis, underscoring the safety of the surgical techniques used for these fractures.

Our findings are consistent with those of Holt et al.,³² indicating a similar incidence of supracondylar humeral fractures in children aged 3-6 years. This reinforces the need for targeted preventive and therapeutic strategies for this age group. Additionally, our study confirms previous research showing a higher prevalence of supracondylar humeral fractures in males.²⁹

The findings of the present study indicate that supracondylar humeral fractures in children can be treated with both anterior and posterior surgical approaches. The results highlight the importance of considering surgeons' preferences and patient-specific factors, such as age, general health, and specific fracture details. Adopting a holistic approach ensures that the chosen surgical method aligns with each patient's unique needs, thereby optimizing the chances of a successful recovery.

This study has several limitations that should be considered. The retrospective design and relatively small sample size may limit the generalizability of the findings. Moreover, the short follow-up duration restricts the assessment of long-term outcomes. Future research should address these limitations by employing prospective designs with larger sample sizes and extended follow-up periods. Additionally, investigating other factors, such as surgical time, cost-effectiveness, pain, functional disability, and quality of life, would provide a more comprehensive understanding of the optimal surgical approach for managing pediatric supracondylar humerus fractures.

Conclusion

The surgical approach can be chosen based on surgeons' preferences and patient-related factors, as both methods offer satisfactory outcomes in terms of ROM and similar functional and cosmetic outcomes with manageable complication rates. However, the observed deviations from normative ROM values in both surgical groups suggest potential limitations in postoperative elbow function. While these deficits were statistically significant, their clinical implications and long-term impact on patient outcomes remain unclear. Future studies with extended follow-up periods are necessary to better understand the functional implications of these ROM deficits and develop targeted rehabilitation strategies for optimizing patient recovery.

Acknowledgement

The authors thank all colleagues and patients who contributed to this study.

Authors Contribution:

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 Mahdi Shahsavan, MD: Visualization, resources, validation, and writing – review & editing.
 Mansour Moradi, MD: Data curation, formal analysis, and investigation.
 Mohammad Alaei, MD: Data collection, and follow-up assessments.
 Mohammad Shahsavan, MD: Conceptualization, project administration, interpretation of results, methodology, and writing – review & editing.

Declaration of Conflict of Interest: The authors do NOT have any potential conflicts of interest for this manuscript.

Declaration of Funding: The authors received NO financial support for the preparation, research, authorship, and publication of this manuscript.

Declaration of Ethical Approval for Study: The study adhered to the Declaration of Helsinki and was approved by the Institutional Review Board (IRB). Specifically, the Isfahan University of Medical Science Institutional Review Board (Approval ID: IR.MUI.MED.REC.1400.464) approved

the study, and informed consent was obtained from all participating patients.

Declaration of Informed Consent: The authors declare that there is no information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript that can be used to identify patients.

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