International Journal of Current Pharmaceutical Research

ISSN- 0975-7066 Vol 17, Issue 2, 2025

Original Article

EARLY SURGICAL INTERVENTION AND OUTCOMES IN PEDIATRIC SUPRACONDYLAR HUMERUS FRACTURES WITH VASCULAR INJURY: A PROSPECTIVE AND RETROSPECTIVE STUDY

ARNAB KUMAR PALO[1*], AFZAL RAZA[2], JIBIN THOMAS[2], DHANANJAY SAHOO[3]

[1]Department of Orthopaedic Surgery, Scb Medical College and Hospital, Cuttak, Odisha, India. [2]Department of Orthopaedic Surgery, Hosmat Hospital, Kalyan Nagar, Bangalore, India. [3]Department of Orthopaedic Surgery, Apollo Hospital, Bhubaneswar, India
*Corresponding author: Arnab Kumar Palo; *Email: arnabpalo3091994@gmail.com

Received: 10 Dec 2024, Revised and Accepted: 22 Feb 2025

ABSTRACT

Objective: Supracondylar humerus fractures (SCHFs) are common in children and may be complicated by vascular injury leading to a "pulseless hand." Prompt recognition and management are crucial to prevent ischemic complications. This study aimed to elucidate the early diagnosis, classification, and outcomes following surgical intervention in pediatric SCHFs with vascular injury.

Methods: In this single-center prospective and retrospective analysis, 25 pediatric patients (age<14 y) with Gartland Type II and III SCHFs and concomitant vascular compromise were included between August 2018 and December 2021. Patients with Gartland Type I fractures or age>14 were excluded. Data on mechanism of injury, preoperative vascular status (pale vs. pink pulseless hand), imaging, surgical approach, and vascular repair techniques were analyzed. Functional outcomes were assessed using the Mayo Elbow Performance Score (MEPS) and radiographic evaluations of deformity.

Results: Of the 25 patients, 76% presented with a pink pulseless hand and 24% with a pale pulseless hand. Vascular intervention was performed in 60% of patients. Brachial artery thrombectomy was the most common procedure (60%), followed by primary arterial anastomosis (26.7%) and venous graft interposition (13.3%). Radial pulse returned spontaneously after bony fixation in 72% of patients. Overall, 20% achieved excellent MEPS, 48% good, and 32% poor outcomes. Cubitus varus deformity occurred in 20% of patients. Statistical analysis demonstrated a significant association between timely vascular intervention and improved functional outcomes ($p<0.05$).

Conclusion: Early recognition and prompt surgical management of vascular injuries in pediatric SCHFs are paramount. Vascular intervention, especially when guided by clinical suspicion and appropriate imaging, improves limb perfusion and functional outcomes. The findings underscore the importance of a standardized management protocol for vascular-compromised SCHFs in children.

Keywords: Pediatric supracondylar fracture, Vascular injury, Brachial artery, Pulseless hand, Surgical intervention, Mayo elbow performance score

DOI: https://dx.doi.org/10.22159/ijcpr.2025v17i2.6059 Journal homepage: https://innovareacademics.in/journals/index.php/ijcpr

INTRODUCTION

Pediatric supracondylar humerus fractures (SCHFs) represent one of the most common elbow injuries in children, accounting for up to 60% of all pediatric elbow fractures [1, 2]. While these fractures generally result from low-energy trauma, such as a fall on an outstretched hand, the potential for devastating complications cannot be overlooked. Among the most critical complications is vascular compromise, typically presenting as a pulseless or poorly perfused hand. The occurrence of vascular injury in association with SCHFs ranges from 2% to 10% in various reports [3, 4]. Prompt identification and management of such injuries are vital to prevent limb ischemia, potential Volkmann's ischemic contracture, and permanent disability.

The vascular compromise in SCHFs often stems from brachial artery involvement, such as thrombosis, spasm, kinking, or transection. Traditionally, the presence of a "pulseless, pale hand" was considered an absolute indication for vascular exploration and repair [5, 6]. However, more recent literature has described cases of "pulseless but pink" hands, where adequate collateral circulation may maintain limb viability, thereby questioning whether immediate vascular exploration is necessary [7]. Such controversies highlight the need for a nuanced approach: some clinicians advocate for a "watch-and-wait" strategy after fracture stabilization, while others emphasize prompt surgical intervention to optimize outcomes.

Despite growing interest in this complex scenario, there remain gaps in understanding the best management protocols and their long-term outcomes. Factors influencing decision-making include the type and mechanism of fracture (extension vs. flexion), fracture classification (Gartland II vs. III), timing of presentation, and associated soft tissue injuries. Additionally, the potential for nerve injuries, compartment syndrome, and residual deformities such as cubitus varus further complicate the clinical picture [8, 9].

This study aims to present a comprehensive assessment of pediatric SCHFs with vascular injury managed at a single tertiary care center. By combining prospective and retrospective data, we aim to clarify the relationship between immediate vascular intervention and subsequent outcomes. Specifically, we evaluate the timing and type of vascular procedures performed, the incidence of spontaneous return of pulse after fracture stabilization, and the ultimate functional and radiographic results. Our findings may inform treatment algorithms, guide clinical decision-making, and potentially influence standard-of-care protocols for managing vascular-compromised SCHFs in children.

In the subsequent sections, we describe our methods, highlight the critical operative details, and present results on functional outcomes and complications. Through a detailed discussion referencing current literature, we underscore the importance of early recognition, accurate assessment, and a tailored surgical approach to improve long-term function and minimize morbidity in these challenging pediatric injuries.

MATERIALS AND METHODS

Study design and setting

This single-center study was conducted at a tertiary care referral center for orthopedics and sports medicine (HOSMAT Hospital, Bangalore). We performed both a prospective and retrospective analysis of pediatric patients with SCHFs presenting with vascular compromise. The study period spanned from Aug 2018 to Dec 2021 (40 mo).

Study population

Children under 14 y of age with Gartland Type II and III supracondylar humerus fractures and concurrent vascular injury (pulseless hand) were included. Exclusion criteria included Gartland Type I fractures, patients older than 14 y, and those who refused surgical intervention.

Sample size and sampling

A total of 25 pediatric patients meeting the inclusion criteria were enrolled. This sample size was determined based on case availability during the study period.

Data collection

Upon admission, demographic data, mode of injury (fall at home or RTA), time from injury to presentation, and local examination findings were recorded. Radiographic evaluation included standard anteroposterior and lateral elbow X-rays. Vascular status was assessed clinically (radial pulse, perfusion, capillary refill) and, when indicated, via Doppler study.

Preoperative workup

All patients underwent a complete blood count, pre-anesthetic evaluation, and relevant serologies. The time from injury to surgery was noted. Patients were classified according to the Gartland system, and vascular injuries were further evaluated intraoperatively.

Surgical intervention

Under appropriate anesthesia, closed or open reduction of the fracture was achieved, followed by K-wire fixation. In patients with persistent pulselessness or suspected arterial injury, the brachial artery was explored. Vascular procedures included thrombectomy, primary repair, or interposition graft as indicated. In some cases, fasciotomy was performed to prevent compartment syndrome.

Postoperative care and follow-up

Postoperative monitoring involved serial neurovascular exams radiographic assessment at 1 w, 3 w, 6 w, and 12 w. Union, range of motion, carrying angle, and perfusion status were documented. Functional outcomes were assessed using the Mayo Elbow Performance Score.

Statistical analysis

Data were analyzed using SPSS v22.0. Categorical variables were presented as frequencies and percentages, and continuous variables as means±standard deviation. Chi-square tests, t-tests, and ANOVA were used as appropriate. A p-value<0.05 was considered statistically significant.

Ethical considerations

Institutional ethical approval was obtained. Informed consent was obtained from parents or guardians.

RESULTS

Overall characteristics

Among 25 pediatric patients, 72% were males and 28% were females. Most patients (56%) were aged 6-10 y, with 28% under 5 y and 16% older than 10 y. The majority (72%) sustained the injury from a fall at home, and 28% from road traffic accidents. A total of 64% presented within 6 h of injury, while 36% arrived later.

Fracture and vascular status

Left-sided SCHFs were slightly more common (60%) than right-sided (40%). According to the Gartland classification, 16% were Type II and 84% Type III. Extension-type fractures predominated (92%). Vascular assessment revealed that 76% presented with a pink pulseless hand and 24% with a pale pulseless hand.

Intraoperative findings and procedures

Vascular intervention was performed in 60% of cases, while 40% did not require initial arterial exploration. Of those needing intervention, brachial artery thrombectomy was the most common procedure (60%), followed by segmental resection and primary anastomosis (26.7%), and venous graft interposition (13.3%). Fasciotomy was required in 28% of cases.

Intraoperatively, brachial artery thrombosis (36%) and spasm (32%) were the most common arterial pathologies, while segmental contusions (16%), kinking (8%), and complete transection (8%) were less frequent.

Return of perfusion and need for reexploration

Notably, 72% of patients regained radial pulse after K-wire fixation alone or within a 48-hour observation period. However, 28% required reexploration surgery, all of whom were initially managed without vascular intervention.

Functional and radiographic outcomes

At final follow-up, 20% of patients achieved excellent MEPS scores, 48% good, and 32% poor results. A small subset (20%) developed cubitus varus deformities of up to 7 degrees. Pin tract infections occurred in 8%, elbow stiffness in 4%, and persistent finger drop in 4%.

Statistical associations

Significant association was found between vascular intervention and improved functional outcome ($p<0.05$). Patients undergoing timely vascular repair had higher rates of excellent or good MEPS scores. Conversely, those managed conservatively were more likely to require reexploration and showed poorer functional scores.

Table 1: Patient demographics and injury characteristics

Variable	Category	n (Total=25)	Percentage (%)
Age (years)	<5	7	28
	6-10	14	56
	>10	4	16
Gender	Male	18	72
	Female	7	28
Mechanism of Injury	Fall at Home	18	72
	Road Traffic Accident (RTA)	7	28
Time from Injury to Hospital	<6 h	16	64
	>6 h	9	36

Table 2: Fracture characteristics

Variable	Category	n (25)	Percentage (%)
Side Involved	Right SC	10	40
	Left SC	15	60
Gartland Classification	Type II	4	16
	Type III	21	84
Fracture Type	Extension	23	92
	Flexion	2	8

Table 3: Vascular status and interventions

Variable	Category	n (25)	Percentage (%)
Vascular status at presentation	Pale and Pulseless	6	24
	Pink and Pulseless	19	76
Significant pre-op clinical findings	None	18	72
	Pucker Sign	3	12
	Blisters	2	8
	Finger Drop	1	4
	Impending Compartment Syndrome	1	4
Vascular intervention performed?	Yes	15	60
	No	10	40
Type of vascular procedure (n=15)	Exploration and Thrombectomy	9	60
	Segmental Resection and Primary Anastomosis	4	26.7
	Segmental Resection and Venous Graft	2	13.3
Fasciotomy required?	Yes	7	28
	No	18	72
Type of brachial artery injury	Thrombosis	9	36
	Spasm	8	32
	Segmental Contusion	4	16
	Kinking	2	8
	Complete Transection	2	8

Table 4: Outcomes and complications

Outcome/Complication	Category	n (25)	Percentage (%)
Return of pulse after fixation	Yes	18	72
	No	7	28
Need for reexploration surgery	Yes	7	28
	No	18	72
Loss of carrying angle	0° (No Varus)	20	80
(Cubitus varus deformity)	5°	4	16
	7°	1	4
Functional outcome (MEPS)	Excellent	5	20
	Good	12	48
	Poor	8	32
Complications	None	16	64
	Cubitus Varus	5	20
	Pin Tract Infection	2	8
	Elbow Stiffness	1	4
	Finger Drop	1	4

Key statistical associations

- Vascular Intervention vs Need for Reexploration: $p<0.001$
- Vascular Intervention vs Functional Outcome: $p=0.041$
- Vascular Intervention vs Fasciotomy: Not Significant ($p>0.05$)

DISCUSSION

Our study examined pediatric SCHFs with vascular compromise, focusing on early surgical management and its impact on outcomes. We found that timely vascular intervention, guided by clinical presentation and imaging, was associated with significantly better functional results and fewer reexplorations.

In line with previous research, the majority of fractures were of the extension type and occurred following a low-energy mechanism such as a fall at home [10-13]. The predominance of pink pulseless hands (76%) reflects the complexity of deciding whether to intervene surgically. Though "pink pulseless" hands may maintain viability through collateral circulation, our findings suggest that a subset still benefits from definitive vascular repair [14, 15]. In fact, radial pulse returned spontaneously after skeletal stabilization alone in over two-thirds of cases, underscoring the importance of fracture reduction and fixation before finalizing vascular management decisions.

The high incidence of arterial thrombosis (36%) and spasm (32%) identified intraoperatively emphasizes the need for immediate exploration in cases of persistent ischemia. Brachial artery thrombectomy and primary repair were the most commonly employed strategies in our cohort. Studies have highlighted that timely vascular reconstruction can restore perfusion and optimize functional recovery [16-18]. Our data further indicate a strong association between vascular repair and improved outcomes. Patients who did not receive early vascular intervention were more likely to require secondary procedures and demonstrated poorer MEPS scores.

Regarding complications, cubitus varus remains a notable deformity after SCHF, reflecting either malreduction or growth disturbance [18]. In our series, 20% exhibited some degree of varus, aligning with reported rates in the literature. Nevertheless, the overall functional outcomes, as measured by MEPS, were encouraging, with 68% achieving excellent or good results. Notably, vascular intervention significantly skewed outcomes toward the better end of the spectrum.

Our study's limitations include a relatively small sample size and single-center design, potentially reducing generalizability. However, given the rarity of vascular compromise in pediatric SCHF, these findings contribute valuable insights to the evolving management strategies. Future prospective multi-center studies with larger sample sizes may further refine algorithms for identifying which patients will benefit most from immediate vascular exploration versus observation.

In conclusion, early recognition and intervention for vascular injury in pediatric SCHFs is crucial. Careful assessment, timely fracture stabilization, and, when indicated, vascular reconstruction improve perfusion, reduce the need for reexploration, and enhance functional outcomes. These findings support a protocol-driven approach that

tailors intervention based on intraoperative findings, ensuring optimal long-term function.

CONCLUSION

This study demonstrates that timely surgical intervention in pediatric SCHFs with vascular injury significantly improves limb perfusion and functional outcomes. A structured approach—including early identification of vascular compromise, prompt fracture stabilization, and judicious vascular exploration—is essential. Patients managed with vascular repair experienced fewer reoperations, better functional scores, and reduced deformities. The findings provide a rationale for protocols emphasizing timely intervention and close monitoring, ultimately enhancing the quality of care and long-term results in this vulnerable patient population.

FUNDING

Nil

AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

REFERENCES

1. Copley LA, Dormans JP, Davidson RS. Vascular injuries and their sequelae in pediatric supracondylar humeral fractures: toward a goal of prevention. J Pediatr Orthop. 1996 Jan-Feb;16(1):99-103. doi: 10.1097/00004694-199601000-00020, PMID 8747364.
2. Garbuz DS, Leitch K, Wright JG. The treatment of supracondylar fractures in children with an absent radial pulse. J Pediatr Orthop. 1996 Sep-Oct;16(5):594-6. doi: 10.1097/00004694-199609000-00009, PMID 8865043.
3. Sabharwal S, Tredwell SJ, Beauchamp RD, Mackenzie WG, Jakubec DM, Cairns R. Management of pulseless pink hand in pediatric supracondylar fractures of humerus. J Pediatr Orthop. 1997;17(3):303-10. PMID 9150016.
4. Griffin KJ, Walsh SR, Markar S, Tang TY, Boyle JR, Hayes PD. The pink pulseless hand: a review of the literature regarding management of vascular complications of supracondylar humeral fractures in children. Eur J Vasc Endovasc Surg. 2008 Dec;36(6):697-702. doi: 10.1016/j.ejvs.2008.08.013, PMID 18851922.
5. Robb JE. The pink pulseless hand after supracondylar fracture of the humerus in children. J Bone Joint Surg Br. 2009 Nov;91(11):1410-2. doi: 10.1302/0301-620X.91B11.23349, PMID 19880881.
6. Brahmamdam P, Plummer M, Modrall JG, Megison SM, Clagett GP, Valentine RJ. Hand ischemia associated with elbow trauma in children. J Vasc Surg. 2011 Sep;54(3):773-8. doi: 10.1016/j.jvs.2011.03.004, PMID 21571488.
7. Wilkins KE. The operative management of supracondylar fractures. Orthop Clin North Am. 1990 Apr;21(2):269-89. doi: 10.1016/S0030-5898(20)31545-5, PMID 2183131.
8. Gartland JJ. Management of supracondylar fractures of the humerus in children. Surg Gynecol Obstet. 1959;109(2):145-54. PMID 13675986.
9. Choi PD, Melikian R, Skaggs DL. Risk factors for vascular repair and compartment syndrome in the pulseless supracondylar humerus fracture in children. J Pediatr Orthop. 2010 Jan-Feb;30(1):50-6. doi: 10.1097/BPO.0b013e3181c6b3a8, PMID 20032742,
10. Battaglia TC, Armstrong DG, Schwend RM. Factors affecting forearm compartment pressures in children with supracondylar fractures of the humerus. J Pediatr Orthop. 2002 Jul-Aug;22(4):431-9. doi: 10.1097/01241398-200207000-00004, PMID 12131436.
11. Steenbrugge F, Macnicol MF. Guidelines and pitfalls in the management of supracondylar humerus fractures in children. Curr Orthop. 2001;15(3):214-9. doi: 10.1054/cuor.2001.0168.
12. Dormans JP, Squillante R, Sharf H. Acute neurovascular complications with supracondylar humerus fractures in children. J Hand Surg Am. 1995 Jan;20(1):1-4. doi: 10.1016/S0363-5023(05)80046-2, PMID 7722246.
13. Houshian S, Mehdi B, Larsen MS. The epidemiology of elbow fracture in children: analysis of 355 fractures with special reference to supracondylar humerus fractures. J Orthop Sci. 2001;6(4):312-5. doi: 10.1007/s007760100024, PMID 11479758.
14. Kumar R, Trikha V, Malhotra R. A study of vascular injuries in pediatric supracondylar humeral fractures. J Orthop Surg (Hong Kong). 2001 Dec;9(2):37-40. doi: 10.1177/230949900100900208, PMID 12118129.
15. Louahem DM, Nebunescu A, Canavese F, Dimeglio A. Neurovascular complications and severe displacement in supracondylar humerus fractures in children: defensive or offensive strategy? J Pediatr Orthop B. 2006 Jan;15(1):51-7. doi: 10.1097/01202412-200601000-00011, PMID 16280721.
16. Shaw BA, Kasser JR, Emans JB, Rand FF. Management of vascular injuries in displaced supracondylar humerus fractures without arteriography. J Orthop Trauma. 1990;4(1):25-9. doi: 10.1097/00005131-199003000-00004, PMID 2313426.
17. Rabee HM, Al Salman MM, Iqbal K, Al Khawashki H. Vascular compromise associated with supracondylar fractures in children. Saudi Med J. 2001 Sep;22(9):790-2. PMID 11590454.
18. Blakey CM, Biant LC, Birch R. Ischaemia and the pink pulseless hand complicating supracondylar fractures of the humerus in childhood: long term follow-up. J Bone Joint Surg Br. 2009 Nov;91(11):1487-92. doi: 10.1302/0301-620X.91B11.22170, PMID 19880895.