

Original Article

EVALUATING VASCULAR INTERVENTION STRATEGIES IN PEDIATRIC SUPRACONDYLAR HUMERUS FRACTURES WITH PULSELESS HAND: A COMBINED PROSPECTIVE-RETROSPECTIVE COHORT STUDYARNAB KUMAR PALO^{1*}, JIBIN THOMAS², DHANANJAY SAHOO³¹Department of Orthopaedic Surgery, Scb Medical College and Hospital, Cuttak, India. ²Department of Orthopaedic Surgery, Hosmat Hospital, Kalyan Nagar, Bangalore, India. ³Department of Orthopaedic Surgery, Apollo Hospital, Bhubaneswar, India*Corresponding author: Arnab Kumar Palo; Email: arnabpalo3091994@gmail.com

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ABSTRACT

Objective: Vascular compromise in pediatric supracondylar humerus fractures (SCHFs) poses a serious threat to limb viability. Controversy persists regarding the necessity and timing of vascular exploration, particularly in “pink pulseless” scenarios. This study evaluated the impact of different vascular management strategies on functional outcomes and the need for reexploration in children with SCHFs and a pulseless hand.

Methods: We conducted a single-center prospective-retrospective study of 25 children under 14 y with Gartland Type II and III SCHFs complicated by vascular compromise. Patients were treated between August 2018 and December 2021. Demographic data, fracture classification, vascular status (pale vs. pink pulseless), and mode of injury were recorded. Management strategies included observation after fracture fixation or immediate vascular exploration (thrombectomy, arterial repair, or venous grafting). Outcomes were assessed by return of radial pulse, need for reexploration, and Mayo Elbow Performance Scores (MEPS).

Results: Of 25 patients, 19 (76%) presented with a pink pulseless hand and 6 (24%) with a pale pulseless hand. Vascular intervention was performed in 60%, while 40% were managed initially without exploration. Radial pulse returned spontaneously in 72% following skeletal stabilization. However, delayed intervention led to a 28% reexploration rate. Patients undergoing timely vascular repair demonstrated significantly better MEPS outcomes ($p < 0.05$) and reduced rates of deformity and complications. No significant association was noted between vascular intervention and the need for fasciotomy.

Conclusion: The decision to perform early vascular exploration in pediatric SCHFs should be guided by clinical presentation and response after bony fixation. Prompt vascular intervention in selected patients improves functional outcomes, reduces the likelihood of reexploration, and enhances overall recovery. These findings support incorporating vascular assessment protocols and early definitive management to optimize limb function and minimize complications.

Keywords: Pediatric supracondylar fracture, Vascular injury, Pink pulseless hand, Brachial artery, Reexploration, Functional outcome

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INTRODUCTION

Pediatric supracondylar humerus fractures (SCHFs) commonly occur in children following simple falls, yet they can be complicated by severe vascular compromise [1, 2]. The brachial artery is at risk due to the displacement and sharp fracture fragments, potentially leading to a “pulseless hand.” While the “pale pulseless” hand has historically mandated urgent vascular intervention, the optimal management of the so-called “pink pulseless” hand remains controversial [3-5]. This entity involves a well-perfused hand (normal capillary refill, warm), but absent palpable or Doppler-detectable radial pulse, challenging surgeons to determine whether immediate vascular repair or watchful waiting is warranted.

The clinical dilemma revolves around balancing the risks of unnecessary vascular exploration, which may increase operative time and complications, against the possibility of ischemia, permanent nerve damage, or limb-length discrepancies if left untreated. Literature on this topic remains inconclusive, and current recommendations vary widely. Some authors suggest that in a “pink pulseless” scenario, fracture reduction and stabilization may restore arterial flow without further intervention [6]. Others argue that the absence of a pulse following appropriate reduction warrants vascular exploration to prevent long-term sequelae.

This study aims to clarify the role of early vascular intervention strategies in pediatric SCHFs with a pulseless hand. By analyzing a cohort of children treated at a tertiary care center, we explore whether immediate vascular exploration improves outcomes, reduces the need for reoperation, and enhances long-term elbow

function. Additionally, we assess the correlation between vascular procedures and common complications such as compartment syndrome, residual deformities (e.g., cubitus varus), and pin tract infections [7-10].

Our dual focus-comparing patients who underwent early vascular intervention with those managed conservatively—provides insights into decision-making algorithms and the timing of exploration. We also examine the utility of clinical and radiographic parameters in guiding management. The findings may help refine standardized protocols and optimize patient care, ultimately improving limb viability and functional outcomes in this vulnerable population.

MATERIALS AND METHODS**Study design and population**

We conducted a single-center prospective and retrospective study at HOSMAT Hospital, Bangalore, from August 2018 to December 2021. Twenty-five pediatric patients (<14 y) with Gartland Type II and III SCHFs and associated vascular compromise (pulseless hand) were included. Patients with Gartland Type I injuries, those refusing surgery, and children older than 14 y were excluded.

Data collection

Demographic details, mechanism of injury, time to presentation, and side of fracture were recorded. Each fracture was classified using Gartland criteria. Vascular status (pink vs. pale pulseless) was assessed clinically and with Doppler when indicated. Preoperative workups included blood tests and anesthesia clearance.

Intervention and surgical technique

All patients underwent closed or open reduction and K-wire fixation under anesthesia. If the radial pulse was not restored following fixation, further vascular exploration was considered. Vascular procedures ranged from thrombectomy and primary repair of the brachial artery to segmental resection with venous graft interposition, depending on intraoperative findings. Fasciotomy was performed if compartment syndrome was suspected.

Postoperative care and evaluation

Regular follow-ups at 1 w, 3 w, 6 w, and 12 w included radiographs, clinical examinations, and neurovascular assessments. Functional outcomes were evaluated using the Mayo Elbow Performance Score (MEPS). The presence of complications such as pin tract infections, stiffness, deformities, and the need for secondary surgeries (reexplorations) were documented.

Statistical analysis

Data were analyzed using SPSS v22.0. Frequencies and percentages were reported for categorical variables. Continuous variables were expressed as mean±standard deviation. Associations between vascular intervention, functional outcomes, and reexploration rates were analyzed using Chi-square tests and ANOVA. A p-value<0.05 was considered statistically significant.

Ethics

Institutional ethics approval was obtained, and informed consent was secured from parents or guardians.

RESULTS

Demographics and presentation

Of the 25 patients, 72% were male. Most were between 6-10 y old (56%). Falls at home were the most common mechanism (72%),

with 28% attributed to road traffic accidents. Sixty-four percent presented within 6 h post-injury.

Fracture and vascular details

Left-sided fractures were more common (60%) than right-sided (40%). Gartland Type III fractures constituted 84% of the sample, reflecting the high severity. Extension-type injuries dominated (92%). Among these children, 76% presented with a pink pulseless hand and 24% with pale pulseless.

Vascular interventions and outcomes

Vascular intervention was undertaken in 60% of patients. Procedures included brachial artery thrombectomy (60%), primary anastomosis (26.7%), and venous grafting (13.3%). In 40% of cases, no initial vascular intervention was performed.

Radial pulse returned spontaneously after skeletal stabilization in 72% of patients, negating the need for further intervention in those cases. However, 28% required reexploration surgery, all from the group initially managed without vascular intervention.

Functional outcomes (MEPS) and complications

MEPS revealed that 20% achieved excellent, 48% good, and 32% poor functional outcomes. Significantly better outcomes were noted in patients who underwent timely vascular intervention (p<0.05). Cubitus varus deformities were observed in 20% of patients, pin tract infections in 8%, and elbow stiffness in 4%.

Association analyses

A significant association was identified between vascular intervention and reduced need for reexploration (p<0.001). Similarly, patients receiving vascular repair showed improved MEPS outcomes (p=0.041). No significant association was observed between vascular intervention and the need for fasciotomy.

Table 1: Comparison of outcomes by initial vascular intervention status

Outcome/Measure	With Intervention (n=15)	Without Intervention (n=10)
Need for Reexploration	0 (0%)	7 (70%)
MEPS: Excellent or Good	13 (87%)	4 (40%)
MEPS: Poor	2 (13%)	6 (60%)

Table 2: Types of brachial artery injury and corresponding procedures

Type of injury	n (25)	Percentage (%)	Typical intervention
Thrombosis	9	36	Thrombectomy
Spasm	8	32	Exploration/Observation
Segmental Contusion	4	16	Resection and Primary Repair or Graft
Kinking	2	8	Correction via Exploration
Complete Transection	2	8	Resection and Venous Graft

Table 3: Functional outcomes (MEPS) by intervention strategy

Functional outcome	With intervention (n=15)	Without intervention (n=10)	p-value
Excellent	4 (27%)	1 (10%)	0.041
Good	9 (60%)	3 (30%)	
Poor	2 (13%)	6 (60%)	

Table 4: Additional complications and reexploration rates

Complication/measure	With intervention (n=15)	Without intervention (n=10)
Reexploration Needed	0 (0%)	7 (70%)
Fasciotomy Required	3 (20%)	4 (40%)
Cubitus Varus Deformity	Reported Overall: 20%	Distribution Not Specified
Pin Tract Infection	Overall: 8%	Distribution Not Specified
Elbow Stiffness	Overall: 4%	Distribution Not Specified

DISCUSSION

This study underscores the importance of individualized vascular management strategies in pediatric SCHFs with compromised

perfusion. Our findings indicate that while many "pink pulseless" hands regain perfusion following fracture reduction and stabilization, a subset benefits from early vascular intervention to optimize functional outcomes and reduce the need for reexploration.

Previous literature has debated the necessity of immediate vascular exploration in the presence of a "pink pulseless" hand [11-13]. Our data support a nuanced approach. Although 72% of patients restored pulses spontaneously, the remaining 28% who needed reexploration all originated from the non-intervention group. This strongly suggests that certain clinical cues-persistent pulselessness, pale discoloration, or Doppler evidence of diminished flow-should prompt early vascular exploration.

We identified brachial artery thrombosis and spasm as the most common arterial pathologies. Timely thrombectomy or primary repair restored perfusion in most cases. These findings mirror other studies indicating that prompt vascular reconstruction prevents ischemic damage and enhances recovery [14, 15]. Moreover, patients managed with vascular intervention exhibited significantly better MEPS, reinforcing that functional improvement aligns with timely restoration of arterial flow.

Interestingly, we found no significant correlation between vascular intervention and fasciotomy. This may indicate that compartment syndrome risk does not necessarily rise solely because of vascular procedures, but rather from underlying trauma severity or delayed presentation [16]. Our complication profile, including cubitus varus and pin tract infections, aligns with known SCHF outcomes reported in the literature [17, 18].

These results must be viewed within the context of our limited sample size and single-center design. However, this scenario is inherently challenging, as vascular injuries in pediatric SCHFs are not exceedingly common. Future research could focus on developing predictive models or decision aids that incorporate clinical, radiographic, and Doppler findings to identify which "pink pulseless" patients require immediate vascular intervention.

Ultimately, our findings advocate for a protocol-driven approach:

1. Prompt assessment of vascular status after fracture stabilization.
2. Consideration of vascular exploration in patients who fail to regain pulses within a defined timeframe or exhibit additional signs of ischemia.
3. Recognition that timely vascular intervention can reduce reoperation rates, improve functional scores, and potentially limit long-term deformities.

Overall, tailoring vascular management to the individual clinical scenario enhances outcomes in pediatric SCHFs with compromised perfusion. Early vascular intervention, guided by careful evaluation, maybe the key to preserving function, minimizing complications, and improving the overall quality of care in this challenging patient population.

CONCLUSION

Our study highlights that in pediatric SCHFs, the decision to perform early vascular intervention should be guided by post-reduction vascular status. While many patients recover adequate perfusion without direct vascular repair, those who fail to regain pulses or show ischemic signs benefit significantly from early exploration. By reducing the likelihood of reexploration and improving functional outcomes, timely vascular intervention emerges as a critical component of comprehensive SCHF management. These results support a protocol-driven approach incorporating careful vascular assessment to optimize the care and prognosis of pediatric patients with compromised limb perfusion after SCHF injuries.

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AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

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