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Lateral approach in gartland type III supracondylar humerus fractures in low resource regions

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Abstract

Introduction: Supracondylar humerus fractures (SCH) in children, often occurring at ages 5 to 6, necessitate treatment due to associated soft tissue and neurovascular injuries.

Method: Between June 2020 and January 2023, 44 patients with type III supracondylar humerus (SCH) fractures were seen in our emergency room. Complications such as skin blisters, compartment syndrome, and brachial artery injury were observed, leading to exclusions from the study. Thirty-six consecutive patients treated with open reduction percutaneous pinning (ORPP) via a lateral approach were retrospectively included. They comprised 28 boys and 8 girls, with an average age of 7.5 years. Postoperative assessment involved monitoring cases with pink, pulseless hands and managing associated fractures, such as ipsilateral femoral shaft and distal radius fractures. Evaluation criteria included Baumann's angle and capitellum alignment with the anterior humeral line, along with Flynn grading for treatment outcomes.

Results: Pre-operatively, 4 (11.11%) anterior interosseous nerve (AIN) injuries were observed, presenting with a pointing index finger, resolving within 6 weeks post-injury. The average duration from emergency presentation to surgery was 8 hours (range, 4-15 hours), with surgery lasting 45 minutes on average (range, 37-55 minutes). Follow-up averaged 12 months (range, 6-15 months), with union achieved in 6.5 weeks on average (range 6 to 8 weeks). Baumann angle difference averaged 4.5° at final follow-up, with one patient exceeding a 15° difference. Notably, 3 patients experienced over a 15° difference in range of motion compared to the non-injured extremity. Outcomes were generally favorable, with 26 patients showing excellent results, 4 good, 3 fair, and 3 poor. Despite variations in range of motion, outcomes were satisfactory, demonstrating the efficacy of ORPP without image intensifier, which not only facilitated clinical and radiological healing but also mitigated radiation exposure and saved time.

Conclusion: Open reduction and percutaneous pinning is a safe and effective procedure to treat supracondylar humerus fractures in children and can be done without C-arm with fairly good accuracy.

Keywords: Percutaneous pinning, fluoroscopy, supracondylar, closed reduction, open reductio

Introduction

Supracondylar humerus fractures (SCH) are among the most common fractures involving the elbow in children, with a peak occurrence typically observed around the ages of 5 to 6 years. While Type I and II fractures often undergo non-operative treatment, Type III fractures, which constitute the majority of SCH cases, usually result from falls onto outstretched hands with the elbow fully extended. These fractures are associated with soft tissue and neurovascular damage, extending in the sagittal plane and exhibiting rotation in the frontal and/or transverse planes. Closed reduction and percutaneous pinning (CRPP) with intra-operative fluoroscopy are commonly favored for treatment. However, due to the unavailability of C-arm imaging in our emergency operation theater, we adopted an alternative approach of open reduction percutaneous pinning (ORPP) for all cases in our study group.

The decision to opt for ORPP was multifaceted. Primarily, it enabled immediate intervention without the need for delayed treatment in a busy main operation theater. Additionally, it mitigated complications associated with fracture deformities and elbow swelling, thereby reducing parental distress and anxiety.

Performing ORPP for SCH fractures via a lateral approach was chosen for its simplicity, requiring minimal dissection while offering optimal access to the fracture site. This approach

also minimized the risk of iatrogenic damage to neurovascular structures.

The objective of our study was to assess the outcomes of SCH humerus fractures treated by ORPP via a lateral approach, without the utilization of C-arm imaging.

ORPP procedures typically involve accessing the fracture site through lateral, medial, anterior, or posterior approaches. Our preference for the lateral approach stemmed from its ease of execution, minimal invasiveness, and favorable anatomical access. By avoiding the use of C-arm imaging, we aimed to evaluate the feasibility and efficacy of this approach in achieving satisfactory outcomes for SCH fractures.

The absence of C-arm imaging necessitated a meticulous surgical technique, relying on anatomical landmarks and intraoperative assessment for accurate reduction and pin placement. Despite this constraint, our approach yielded promising results, emphasizing the importance of surgical skill and clinical judgment in the absence of advanced imaging modalities.

Need of the study

The study "Lateral Approach in Gartland Type III Supracondylar Humerus Fractures in Low Resource Regions" is propelled by crucial factors. Firstly, in low-resource areas, the lack of advanced medical equipment necessitates alternative techniques for managing complex fractures like Gartland Type III supracondylar humerus fractures. Limited access to specialized treatments underscores the need for exploring alternative approaches to ensure timely and appropriate care for all patients. While closed reduction and percutaneous pinning (CRPP) are preferred, their feasibility is hindered in low-resource settings due to the lack of C-arm imaging, prompting exploration of alternative surgical strategies. Evaluating the efficacy and safety of the lateral approach in managing these fractures is crucial for informing clinical decision-making and improving patient outcomes. Additionally, investigating the lateral approach's ability to reduce complications and enhance patient safety addresses significant concerns. Generating empirical data on its effectiveness is vital for promoting evidence-based practice and standardizing treatment protocols in resource-limited settings, thus enhancing the quality of care for pediatric patients with complex elbow fractures.

The study by Abbott MD, Buchler L, Loder RT, Caltoun CB. Aimed to evaluate outcomes and complications in Gartland type III pediatric supracondylar humerus fractures treated at a pediatric level-one trauma center over 7 years, specifically examining the impact of time to surgery on complication rates and the necessity for open reduction. Analyzing 297 pediatric patients with closed Gartland type III fractures between December 2004 and December 2011, the study assessed operative time, conversion to open procedure, and perioperative/postoperative complications. Findings revealed 8.4% of children experienced complications, with 9.4% requiring open reduction. Surprisingly, the time from the emergency department to the operating room didn't significantly affect complication rates or operative time. However, crossed pinning posed a higher risk of complications and iatrogenic nerve injuries, especially in boys and older patients. These results suggest a less urgent approach to treating Gartland type III supracondylar humerus fractures and highlight the risks associated with crossed pinning versus lateral pinning.

Aim of the study

To evaluate the efficacy, safety, and feasibility of utilizing the lateral approach as an alternative surgical technique for

managing Gartland Type III supracondylar humerus fractures in low-resource regions.

Methodology

A total of 44 patients with type III SCH fractures presented to the emergency room in our institution between June 2020 and January 2023. Three patients had skin blisters and two had compartment syndrome developed due to mismanagement by traditional bonesetters. One patient presented with pulseless cool hand and had brachial artery injury. Vascular repair together with fracture reduction was done via anterior approach. 2 cases had unacceptable reductions on post-operative radiographs and were re-operated in our main operation theatre under C- arm. All these 8 cases were excluded from the study.

In this retrospective study we included 36 patients which were consecutively treated in our emergency operation theatre by ORPP via lateral approach. The patients consisted of 28 boys and 8 girls with a mean age of 7.5 years (range 3-14 years). Four cases in the study group had pink pulseless hand and were urgently fixed and observed for an average of five days postoperatively. Two cases were open type I fractures and were also included in the study. Two patients had sustained ipsilateral femoral shaft fracture and were managed by intramedullary elastic nails. One patient had ipsilateral distal radius fracture which was managed non-operatively.

Baumann's angle and the relationship of the capitellum to the anterior humeral line (Fig. 1) were used for determining the adequacy of reduction [4]. Flynn [5] grading system was used to assess the results of treatment (Table 1).



Fig 1: Drawing anterior humeral line (a) transecting capitellum and Baumann angle (b) on radiographs

Table 1: Flynn criteria

Result	Loss of Baumann angle (degrees)	Loss of motion (degrees)
Excellent	0-5	0-5
Good	6-10	6-10
Fair	11-15	11-15
Poor	>15	>15

Surgical Technique

After general anaesthesia, patients were placed in a lateral decubitus position. Pneumatic tourniquet was used in all cases. Open reduction was performed by a 3-5 cm curvilinear skin incision over the lateral aspect of elbow. After blunt dissection, fracture was visualised by using small Hohmann

elevators and any interposing structure was removed. Fracture hematoma was curetted and wound irrigation was done. Reduction was achieved by applying pressure by a thumb on the proximal fragment and traction performed on the forearm while flexing the elbow. Reduction was maintained by manual pressure of the assistant. After reduction, lateral or crossed smooth K-wires (1.5 or 1.8 mm) were inserted percutaneously (Figures 2 and 3). To insert the K-wire from the medial side care was taken to protect ulnar nerve. For this elbow was extended and the epitrochlea was palpated with thumb and then the thumb was moved posteriorly. In some cases with gross swelling ulnar nerve was protected by using a mini- incision. Various pin configurations were used (Table 2).

Table 2: Pin configurations used for surgical fixation

Pin configuration	Number of cases
3 lateral pins	
All parallel	4
Divergent	3
2 lateral pins	
Both parallel	4
Divergent	1
2 lateral pins and one medial pin	
Parallel lateral pins	11
Divergent lateral pins	13



Fig 2: A case of type III SCH fracture in a 6y old boy (a), fixed by ORPP with 3 lateral parallel K-wires(b), at 3 weeks after removing K-wires(c), at 4 month follow-up (d). Distal radius fracture in this case was managed conservatively

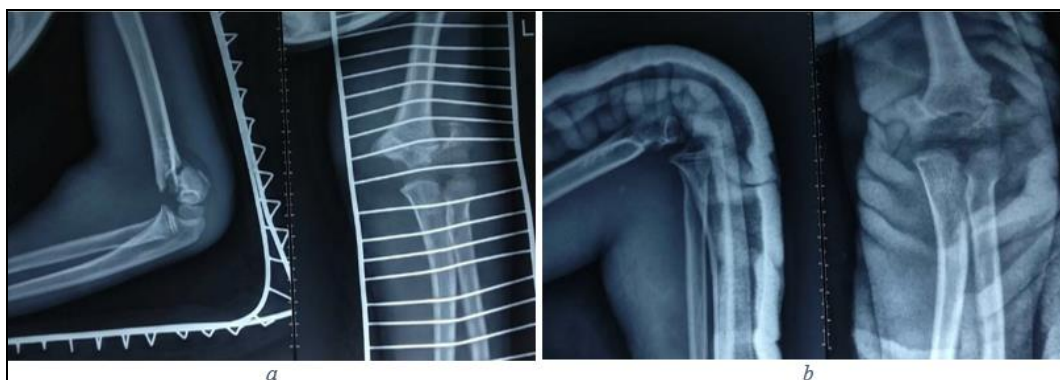




Fig 3: A case of extension type SCH fracture in a 10 y old boy (a), initially reduced in a POP slab (b), fixed by using 2 divergent K-wires laterally and 1 K- wire from medial side (c), ulnar nerve was protected in this case by using a mini-incision

As the C-arm was not available in our emergency operating theatre confirmation of the reduction was performed with direct radiography. 2 patients had unacceptable reduction on post-operative radiographs and needed re-operation. These were excluded from the study group. A long arm POP slab was applied in 50-70 degrees of flexion depending on pre-operative swelling. The patients were discharged 12-24h after surgery. The pins and POP slab were removed in the OPD after 3 weeks followed by active assisted range of motion (ROM) exercises of the elbow.

Result

Pre-operatively, there were 4 (11.11%) anterior interosseous nerve (AIN) injuries, with the typical presentation of pointing index finger. All cases resolved spontaneously within 6 weeks after injury. The average duration from presentation in the emergency to the surgery was 8 hours (range, 4-15 hours). Average duration of surgery was 45 minutes (range, 37- 55 minutes). Average follow-up was 12 months (range, 6-15 months). Average time to union was 6.5 weeks (range 6 to 8 weeks). At the final follow-up, the mean difference in Baumann angle was 4.5°. One patient had a Baumann angle difference of more than 15°. Three patients had more than 15° difference in ROM compared to that of the non-injured extremity. 26 patients had excellent results, 4 had good results, 3 had fair results, and 3 had poor results (Table 3). The results were much better in terms of Baumann angle difference than in terms of average ROM achieved. In the patients with poor functional results, stiffness, and loss of motion were marked and needed prolonged physiotherapy. ORPP without using image intensifier not only had good results in terms of clinico-radiological healing but also avoided exposure of radiation and was time saving.

Table 3: Final Results

Result according to Flynn criteria	Number of patients
Excellent	26
Good	4
Fair	3
Poor	3

Complications

Two (5.55%) patients had a superficial pin track infection that resolved with oral antibiotics and dressings. Additionally, there was one (2.7%) iatrogenic ulnar nerve injury which resolved completely by the fourth postoperative month. One patient developed myositis ossificans around the elbow. 2

patients needed revision surgery under C-arm as the reduction was not acceptable on post-operative radiographs. These two cases were excluded from the study.

Discussion

Closed reduction and percutaneous pinning (CRPP) under C-arm imaging is the conventional surgical approach for displaced supracondylar humerus (SCH) fractures. However, in our setting, the unavailability of C-arm imaging in the emergency operation theatre, combined with challenges in achieving satisfactory fracture alignment through intraoperative closed reduction attempts, led us to adopt open reduction percutaneous pinning (ORPP) for all cases. This study aimed to assess the safety and effectiveness of ORPP via a lateral approach for displaced SCH fractures without C-arm imaging.

Despite concerns regarding iatrogenic soft tissue injury associated with ORPP, meticulous dissection and fracture reduction minimized major complications, with only one ulnar nerve injury observed during pin insertion. Meta-analyses by Bo Gou *et al.* found no significant differences in outcomes between CRPP and ORPP, aligning with our findings. Pre-operative neurological injuries, primarily anterior interosseous nerve (AIN) injuries, were noted in 11.11% of our cases, consistent with literature reports.

Additionally, we encountered a 2.7% iatrogenic nerve injury rate, similar to published rates. Postoperative radiographs revealed loss of reduction in two patients with type IV SCH fractures, necessitating re-operation under fluoroscopic guidance. Superficial pin tract infections occurred in 5.5% of cases, within the reported range.

Despite these complications, the lateral approach yielded good functional outcomes, consistent with findings by Keskin and Sen. However, our study's limitations include variations in case complexity and surgical performance among multiple surgeons. Some cases posed challenges due to muscle and neurovascular interposition, as well as open fractures requiring additional procedures and extended operative times.

Conclusion

In conclusion, our study investigated the safety and effectiveness of open reduction percutaneous pinning (ORPP) via a lateral approach for displaced supracondylar humerus (SCH) fractures in the absence of C-arm imaging, due to its unavailability in our emergency operation theatre. Despite concerns regarding iatrogenic soft tissue injury, meticulous dissection and fracture reduction resulted in minimal major complications, with only one ulnar nerve injury observed

during pin insertion. Meta-analyses have shown comparable outcomes between ORPP and closed reduction percutaneous pinning (CRPP), supporting our findings. Notably, while pre-operative neurological injuries, primarily anterior interosseous nerve (AIN) injuries, were consistent with literature reports, our iatrogenic nerve injury rate was within the expected range. Loss of reduction in two patients necessitated re-operation under fluoroscopic guidance, highlighting the challenges of diagnosing complex fractures without intraoperative imaging. Despite a higher rate of superficial pin tract infections compared to literature, functional outcomes were satisfactory with the lateral approach. However, variations in case complexity and surgical performance among multiple surgeons pose limitations to our study. Further research addressing these limitations is warranted to refine surgical techniques and optimize patient care in managing displaced SCH fractures in resource-limited settings without C-arm imaging.

Conflict of interest: The authors certify that they have no involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this paper.

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