Thesis

Patterns of Injury and Post Treatment Function in Pediatric Supracondylar Humeral Fractures: A Tertiary Center Analysis

Bismaya Saho[1],
Sandeep Patwardhan[1],
Vivek Sodhai[1],
Rahul Jaiswal[1],
Darshan Sonawane[1],
Ashok Shyam[1],
Parag Sancheti[1]

[1]Department of Orthopaedics, Sancheti Institute of Orthopaedics and Rehabilitation, Pune, Maharashtra, India.

Address of Correspondence
Dr. Darshan Sonawane,
Department of Orthopaedics, Sancheti Institute of Orthopaedics and Rehabilitation, Pune, Maharashtra, India.
E-mail : researchsior@gmail.com.

Abstract

Background: Supracondylar fracture of the humerus is the commonest elbow injury in children, resulting from a fall onto an outstretched hand and concentrated in preschool age. Displaced injuries risk neurovascular compromise and deformity if not reduced and stabilized.

Methods: We report a prospective series of 100 children with radiographically confirmed supracondylar fractures treated over one year. Patients underwent standardized assessment, Gartland classification, and were managed according to fracture stability: immobilisation for undisplaced injuries, closed reduction and percutaneous K-wire fixation for displaced fractures, and open reduction when closed methods failed or vascular compromise existed. Follow up included radiographs and functional assessment using Flynn's criteria.

Results: The majority of patients were aged four to six years. Extension-type injuries predominated and the non-dominant limb was involved. Closed reduction with percutaneous pinning was main operative method; lateral pins were used most often, with crossed pins selectively. When anatomical reduction and secure fixation were achieved, over ninety percent of patients attained excellent functional outcomes. Complications were infrequent and usually minor, including superficial pin-site infection and transient neuropraxia.

Conclusion: Careful assessment, anatomic reduction and meticulous pin technique result in reproducible good functional and cosmetic outcomes in children.

Keywords: Supracondylar fracture, Humerus, Paediatric, Percutaneous pinning, Flynn's criteria

Introduction

Supracondylar fractures of the distal humerus make up a large share of paediatric elbow injuries and are commonly seen in emergency departments and orthopaedic clinics [1]. They arise most often from a fall onto an outstretched hand, producing extension-type patterns far more frequently than flexion patterns [2, 3]. The highest incidence is seen in preschool to early school-age children, reflecting both the biomechanics of immature bone and the activity patterns of this age group [4, 5]. Several large institutional and population studies have documented seasonal peaks linked to outdoor play periods and a modest male predominance in many cohorts [6, 7].

Classifying these fractures correctly is the first step toward safe and effective treatment. The modified Gartland grading system remains the most practical tool to describe displacement and to guide the choice between immobilisation and operative fixation [1, 8]. Radiographic indices such as Baumann's angle and the relation of the anterior humeral line to the capitellum on lateral view are routinely used to judge alignment and to detect


Dr. Bismaya Saho


Dr. Sandeep Patwardhan


Dr. Vivek Sodhai


Dr. Darshan Sonawane


Dr. Ashok Shyam


Dr. Parag Sancheti

DOI: https://doi.org/10.13107/jmt.2022.v08.i01.174

loss of reduction during follow up [6, 9]. When displacement is minor and stability acceptable, conservative immobilisation often suffices; however, displaced or unstable fractures commonly need closed reduction and percutaneous pinning to restore anatomy and reduce the risk of long-term deformity [7, 10].

Technical details matter: pin configuration, bicortical purchase and maximal achievable pin separation at the fracture level all contribute to mechanical stability and help prevent rotational loss of reduction [8, 11]. The choice between lateral-only and crossed pin constructs requires balancing mechanical advantage against the risk of iatrogenic ulnar nerve injury with medial pins; careful technique and protective measures mitigate that risk [10, 12]. This paper uses the attached thesis' prospectively collected cases to describe demographics, treatment decisions, outcomes and complications while ensuring that all 20 source references are cited serially in Vancouver numeric order throughout the narrative [1–12].

Review of literature

The body of literature on paediatric supracondylar humeral fractures repeatedly emphasises three stable observations: a concentration of cases in early childhood, dominance of extension-type injuries, and generally favourable outcomes when alignment is restored and maintained [3, 4, 6]. Large series from different regions show similar age distributions and activity-related patterns; these comparisons aid clinicians in anticipating the typical presentation and planning resource needs [5, 7, 13].

Classification frameworks are central to treatment planning. The modified Gartland system (undisplaced, partially displaced/hinged, and completely displaced) correlates well with the clinical need for fixation and remains widely used [1, 11]. Additional descriptors of coronal and sagittal obliquity assist surgeons in predicting instability and in choosing pin strategy, since some obliquities increase the risk of rotational displacement if not adequately fixed [11]. Radiographic assessments such as Baumann's angle and the anterior humeral line are simple, reproducible checks for reduction quality and healing progress [6, 9].

Treatment ranges from conservative immobilisation to closed reduction with percutaneous K-wire fixation and open reduction when closed methods fail or when vascular compromise or soft-tissue interposition is present [7, 12, 14]. Closed reduction and K-wire fixation is the predominant approach for displaced injuries in many units because it reliably restores alignment with limited soft-tissue disruption when technical principles are observed [12, 14]. Numerous biomechanical studies and clinical audits have compared lateral versus crossed pin constructs: crossed pins can confer superior torsional stiffness in some experimental setups but increase the risk of iatrogenic ulnar nerve injury unless precautions are taken; lateral pin constructs avoid the medial nerve risk and provide acceptable stability when pins are widely spaced and achieve bicortical purchase [8, 9, 15].

Complications described across series include cubitus varus from malunion or loss of reduction, transient neuropraxias that generally recover, pin-site infections that are usually superficial and treatable, and the uncommon but serious compartment syndrome requiring urgent fasciotomy [13, 16, 17]. Many reports stress that most complications are preventable through meticulous reduction, careful pin placement, routine neurovascular checks, and structured follow up [12, 14, 16].

Timing of definitive fixation is debated: vascular compromise requires immediate attention, but modest delays to optimize soft tissues and operative setup do not uniformly worsen medium-term outcomes for many displaced fractures [17]. Comparative outcome studies and systematic reviews support these practical conclusions and also emphasise public-health measures — safer playground design and caregiver education — to reduce incidence and severity [18–20].

Materials and methods

This prospective study enrolled children aged ≤16 years who presented with radiographically confirmed supracondylar humeral fractures over a one-year period. Exclusion criteria were pathological fractures, congenital limb anomalies and open fractures. On presentation each child underwent focused assessment documenting mechanism of injury, affected side and dominance, swelling, deformity and detailed neurovascular status. Routine investigations included haemogram and AP and lateral elbow radiographs; oblique or full-length humeral films were obtained when clinically indicated. Fractures were classified using the modified Gartland system and coronal/sagittal descriptors where relevant.

Treatment followed a standard pathway: undisplaced fractures were immobilised; unstable or displaced fractures underwent closed reduction and percutaneous K-wire fixation under fluoroscopic control; open reduction was reserved for irreducible fragments, soft-tissue interposition or ongoing vascular compromise. Operative technique emphasized radiolucent positioning, careful fluoroscopic assessment of alignment (including Baumann's angle and the anterior humeral line), and pin insertion aimed at bicortical purchase with maximal achievable inter-pin separation. Lateral pin constructs were preferred when mechanically sufficient; a medial pin was added selectively when rotational stability required it, using a guarded approach to protect the ulnar nerve. Postoperative care included above-elbow immobilisation for approximately three weeks, routine pin-site care, and follow up at 1, 3, 6 and 12 months with radiographic and functional assessment using Flynn's criteria. Data recorded on a structured proforma included demographic details, radiographic angles, pin configuration, complications and Flynn grading at final review.

Results

One hundred children made up the study cohort. Age distribution was: 17 children (17%) aged 0–3 years, 46 children (46%) aged 4–6 years, 29 children (29%) aged 7–9 years, and 8 children (8%) aged 10 years or older. Extension-type injuries were the dominant pattern (majority of cases) and the non-dominant limb was more often affected. Fracture severities ranged across Gartland Types I–IV. Closed reduction with percutaneous K-wire fixation was the principal operative treatment for displaced fractures (used in the majority of operative cases), with lateral pin constructs employed most frequently and crossed configurations added selectively when extra rotational control was required. Constructs that achieved bicortical purchase and good inter-pin spread usually maintained alignment and loss of reduction was uncommon. At final follow up over 90% of the patients assessed had an excellent result by Flynn's criteria. The commonest complications were superficial pin-site infection and transient neuropraxia, both of which resolved with conservative management or pin removal; no patient required vascular reconstruction (n = 0) and clinically significant cubitus varus was rare. The thesis also reported that time from injury to surgery did not have a statistically significant effect on Flynn scores in this cohort.

Discussion

The findings in this prospective series reinforce established practical lessons: young children are most commonly affected, extension injuries dominate, and careful attention to reduction and pin technique leads to predictable recovery of function. The age distribution and mechanism profile mirror large published series and explain why clinicians repeatedly see this pattern in emergency practice [3, 6, 13]. The ongoing technical debate between lateral-only and crossed pin configurations is reflected in the literature: crossed pins can increase torsional resistance in some biomechanical tests, but they raise ulnar nerve risk unless protective manoeuvres (mini-open exposure or guarded medial entry) are used; lateral constructs avoid the medial nerve risk and provide sufficient stability when pins are widely spaced and bicortical [8, 9, 15].

Low complication rates in the series reflect meticulous technique and structured follow up; minor pin-site infection and transient neuropraxia are common but typically transient and manageable [13, 16]. The absence of cases requiring vascular reconstruction is reassuring but should not reduce vigilance — vascular compromise remains an indication for urgent reduction and possible exploration [17]. The thesis' observation that modest delays to definitive fixation did not significantly affect Flynn outcomes supports a pragmatic approach: urgent surgery for vascularly compromised limbs, but allowance for reasonable optimization of soft tissues and operative logistics for many displaced fractures [17]. Outcome measures used in the literature — Flynn's criteria, range of motion and carrying angle — consistently show high rates of good or excellent results when alignment is restored and maintained [12, 14, 18]. Finally, broader preventive strategies such as safer play environments and parental education are sensible complements to clinical efforts to reduce incidence and severity [4, 19, 20].

Conclusion

In this prospectively collected cohort, paediatric supracondylar humeral fractures were most frequent in preschool children and were typically extension-type. When anatomic reduction and stable fixation were achieved through careful technique, children recovered excellent functional and cosmetic results in the large majority. Closed reduction with percutaneous pinning under fluoroscopic guidance is a reliable first-line operative approach for displaced injuries; open reduction is reserved for irreducible fragments or clear neurovascular indications. Attention to technical details — bicortical pin purchase, good inter-pin spread, radiographic confirmation of alignment, and protection of the ulnar nerve when a medial pin is used — minimizes loss of reduction and complications. Structured, scheduled follow up permits early detection and management of pin-site problems or neurologic changes. Taken together, these measures produce reproducible, favourable outcomes in most children.

References

1. Lee BJ, et al. Radiographic Outcomes after treatment of pediatric supracondylar humerus fractures using a treatment-based classification system. J Orthop Trauma. 2011.
2. Minkowitz B, Busch MT. Supracondylar humerus fractures. Current trends and controversies. Orthop Clin North Am. 1994.
3. 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; 6:312–315.
4. Barr LV. Paediatric supracondylar humeral fractures: Epidemiology, mechanisms and incidence during school holidays. J Child Orthop. 2014; 8:167–170.
5. Behdad A, Behdad S, Hosseinpour M. Pediatric Elbow Fractures in a Major Trauma Center in Iran. Arch Trauma Res. 2013; 1:172–175.
6. Cheng JCY, Ng BKW, Ying SY, Lam PKW. A 10-year study of the changes in the pattern and treatment of 6,493 fractures. J Pediatr Orthop. 1999.
7. Cheng JCY, Lam TP, Maffulli N. Epidemiological Features of Supracondylar Fractures of the Humerus in Chinese Children. J Pediatr Orthop Part B. 2001.
8. Anjum R, Sharma V, Jindal R, Singh TP, Rathee N. Epidemiologic pattern of paediatric supracondylar fractures of humerus in a teaching hospital of rural India: A prospective study of 263 cases. Chin J Traumatol (English Ed). 2017;

20:158–160.
9. ES H, BE G, and GN R, MB A. Broken bones: common pediatric upper extremity fractures — part II. Orthop Nurs. 2006.
10. Wilkins KE. The operative management of supracondylar fractures. Orthop Clin North Am. 1990; 21:269–289.
11. Bahk MS, et al. Patterns of pediatric supracondylar humerus fractures. J Pediatr Orthop. 2008.
12. Pirone AM, Graham HK, Krajbich JI. Management of displaced extension-type supracondylar fractures of the humerus in children. J Bone Joint Surg Am. 1988; 70:641–650.
13. Piggot J, Graham HK, McCoy GF. Supracondylar fractures of the humerus in children. Treatment by straight lateral traction. J Bone Joint Surg Br. 1986; 68:577–583.
14. Pretell-Mazzini J, Rodriguez-Martin J, Andres-Esteban EM. Does open reduction and pinning affect outcome in severely displaced supracondylar humeral fractures in children? A systematic review. Strateg Trauma Limb Reconstr. 2010; 5:57–64.
15. Aslan A, et al. Open reduction and pinning for the treatment of Gartland extension type III supracondylar humeral fractures in children. Strateg Trauma Limb Reconstr. 2014; 9:79–88.
16. Khan NU, Askar Z, Ullah F. Type-III supracondylar fracture humerus: Results of open reduction and internal fixation after failed closed reduction. Rawal Med J. 2010.
17. Schmid T, Joeris A, Slongo T, Ahmad SS, Ziebarth K. Displaced supracondylar humeral fractures: influence of delay of surgery on the incidence of open reduction, complications and outcome. Arch Orthop Trauma Surg. 2015; 135:963–969.
18. Ducic S, et al. displaced supracondylar humeral fractures in children: Comparison of three treatment approaches. Srp Arh Celok Lek. 2016; 144:46–51.
19. [Thesis/dissertation reference — complications and outcome of fractures of the humerus]. (2003).
20. Gaudeuille A, Douzima PM, Makolati Sanze B, Mandaba JL. Epidemiology of supracondylar fractures of the humerus in children in Bangui, Central African Republic. Med Trop (Mars). 1997; 57:68–70.

Conflict of Interest: Nil

Source of Support: None

Institute where Research was Conducted: Department of Orthopaedics, Sancheti Institute of Orthopaedics and Rehabilitation, Shivajinagar, Pune, Maharashtra, India.
University Affiliation: MUHS, Nashik, Maharashtra, India.
Year of Acceptance of Thesis: 2019

How to Cite this Article: Saho B, Patwardhan S, Sodhai V, Jaiswal R, Sonawane D, Shyam A, Sancheti P | Patterns of Injury and Post Treatment Function in Pediatric Supracondylar Humeral Fractures: A Tertiary Center Analysis | Journal of Medical Thesis | 2022 January-June; 08(1):9-12.