

Management and Outcomes of Displaced Supracondylar Humerus Fractures in Children

Dr Vinit Panchiwala¹, Dr Mohit Dulhanani², Dr Nikhil Panchiwala³, Dr Baiju Patel⁴

¹Assistant Professor, Department of Orthopaedics, Dr ND Desai Faculty of Medical Science and Research, Dharamsinh Desai University, Nadiad, Gujarat, India

²Senior Resident, Department of Orthopaedics, Geetanjali Medical College & Hospital, Udaipur, Rajasthan, India

³Senior Resident, Department of Orthopaedics, Dr ND Desai Faculty of Medical Science and Research, Dharamsinh Desai University, Nadiad, Gujarat, India

⁴Associate Professor, Department of Orthopaedics, Dr ND Desai Faculty of Medical Science and Research, Dharamsinh Desai University, Nadiad, Gujarat, India

Corresponding author: Dr Vinit Panchiwala, Department of Orthopaedics, Dr ND Desai Faculty of Medical Science and Research, Dharamsinh Desai University, Nadiad, Gujarat, India

Email id: Vjpanchiwala@gmail.com

Conflict of interest: No! Conflict of interest is found elsewhere considering this work.

Source of Funding: There was no financial support concerning this work.

Management and Outcomes of Displaced Supracondylar Humerus Fractures in Children

Abstract

Background: Supracondylar fractures of the humerus are among the most common elbow fractures in children. Displaced fractures require accurate reduction and stable fixation to restore anatomical alignment and prevent complications such as malunion, neurovascular injury, loss of reduction, and restriction of elbow movement. Closed reduction and percutaneous K-wire fixation is widely used because it provides stable fixation with minimal soft-tissue disruption.

Aim: To evaluate the anatomical and functional outcomes of displaced supracondylar fractures of the humerus in children treated with closed reduction and percutaneous K-wire fixation, and to document intraoperative and postoperative complications and follow-up until fracture union and return of function.

Materials and Methods: This clinical observational study included 150 children with displaced supracondylar fractures of the humerus who underwent closed reduction and percutaneous K-wire fixation. Preoperative assessment included recording of age, sex, side of involvement, mode of injury, clinical findings, and radiological characteristics. Following satisfactory closed reduction under image-intensifier guidance, percutaneous K-wires were used to stabilize the fracture. Patients were monitored for intraoperative and postoperative complications and followed clinically and radiologically until fracture union and functional recovery. Anatomical outcome was assessed according to fracture alignment, radiological union, and residual deformity, while functional outcome was evaluated on the basis of elbow range of motion and return to normal activities.

Results: Of the 150 patients, 94 (62.7%) were males and 56 (37.3%) were females. The most commonly affected age group was 6–10 years (52.0%). The right side was involved in 85 (56.7%) patients and the left side in 65 (43.3%). Fall while playing was the most common mode of injury (54.0%). Closed reduction was successfully achieved in all patients. Postoperative complications occurred in 18 (12.0%) patients, with pin-site infection being the most common complication (4.7%). Fracture union was achieved in 147 (98.0%) patients. Satisfactory radiological alignment was observed in 139 (92.7%) patients. Full or near-normal elbow range of motion was achieved in 131 (87.3%) patients. Excellent and good functional outcomes were observed in 81 (54.0%) and 48 (32.0%) patients, respectively. Overall, 136 (90.7%) patients returned to normal activities.

Conclusion: Closed reduction and percutaneous K-wire fixation provides satisfactory anatomical restoration, reliable fracture union, and good functional recovery in children with displaced supracondylar fractures of the humerus. The procedure is minimally invasive and was associated with a relatively low rate of complications in the present study. Careful reduction, appropriate K-wire placement, neurovascular assessment, and regular postoperative follow-up are essential for achieving favorable outcomes.

Keywords: Supracondylar fracture; Humerus; Children; Closed reduction; K-wire fixation; Percutaneous pinning; Functional outcome; Fracture union.

How to cite this article: Vinit Panchiwala¹ Dr Mohit Dulhanani² Dr Nikhil Panchiwala³ Dr Baiju Patel⁴. Type: Original research. Int J Drug Deliv Technol. 2026;16(82s):410-416. DOI: 10.25258/ijddt.16.82s.50.

Introduction

Supracondylar fracture of the humerus is one of the most common elbow injuries encountered in the

pediatric population and represents a major proportion of fractures requiring operative intervention in

children. These fractures generally occur after a fall on the outstretched hand, particularly during play and other physical activities. The injury is especially important because displacement of the distal fragment may result in instability, neurovascular compromise, malunion, and restriction of elbow function if appropriate treatment is not instituted promptly [1,2]. The Gartland classification remains widely used for assessing the degree of displacement and stability of pediatric supracondylar humeral fractures. While minimally displaced fractures can often be managed conservatively, displaced fractures, particularly unstable extension-type injuries, generally require reduction and fixation to restore alignment and maintain the reduction during healing [1,3]. The management of displaced supracondylar fractures has evolved considerably, with closed reduction and percutaneous fixation becoming an established method of treatment [4,5].

The principal objectives of treatment are to restore the anatomical alignment of the distal humerus, maintain fracture stability until union, prevent neurovascular complications, and achieve satisfactory functional recovery of the elbow. Closed reduction minimizes additional soft-tissue trauma and avoids the morbidity associated with open surgical exposure. When an acceptable reduction is achieved, percutaneous Kirschner-wire (K-wire) fixation provides stabilization while allowing fracture healing without extensive surgical dissection [5,6].

Different configurations of K-wire fixation have been described for maintaining reduction. The mechanical stability of the construct depends on factors such as pin configuration, number of pins, pin divergence, and purchase in the distal humeral fragments. Biomechanical studies have demonstrated differences in torsional stability among various pin configurations, emphasizing the importance of appropriate wire placement during fixation [7]. Clinical studies have also demonstrated that the stability of fixation is closely related to the configuration and placement of the K-wires [8].

Although closed reduction and percutaneous pinning is associated with good results in the majority of children, complications may occur. These include pin-site infection, loss of reduction, nerve injury, vascular complications, malunion, cubitus varus, elbow stiffness, and other complications related to the fracture or its treatment. The timing of surgery and the technique used for reduction and fixation may also influence perioperative complications [9,10]. Careful assessment before treatment and appropriate postoperative follow-up are therefore essential.

Functional assessment following treatment is an important component of evaluating the success of management. Restoration of elbow range of motion,

alignment, carrying angle, fracture union, and return to normal activities provide useful indicators of the anatomical and functional outcome. Long-term clinical experience has established closed reduction and percutaneous pin fixation as an effective treatment approach for appropriately selected displaced supracondylar fractures in children [2,4,6].

The present study was undertaken to evaluate the management of displaced supracondylar fractures of the humerus in children treated by closed reduction and percutaneous K-wire fixation. The study records demographic and injury-related characteristics, evaluates anatomical and functional outcomes, documents intraoperative and postoperative complications, and follows patients until fracture union and return of elbow function.

Material and Methods

This was a clinical observational study conducted to evaluate the anatomical and functional outcomes of displaced supracondylar fractures of the humerus in children treated by closed reduction and percutaneous K-wire fixation.

The study included pediatric patients presenting with displaced supracondylar fractures of the humerus who fulfilled the predefined eligibility criteria and were treated by closed reduction followed by percutaneous K-wire fixation. Children with displaced supracondylar fractures of the humerus, particularly extension-type fractures requiring operative stabilization, were included in the study. Patients in whom satisfactory reduction could be achieved by closed manipulation and who were available for postoperative clinical and radiological follow-up until fracture union and functional recovery were included. Patients with open supracondylar fractures, associated fractures around the elbow requiring additional operative procedures, pathological fractures, previous fracture or deformity of the affected elbow, and patients requiring open reduction because satisfactory closed reduction could not be achieved were excluded from the study. Patients with inadequate postoperative follow-up were also excluded.

All patients underwent detailed clinical evaluation at presentation. Demographic characteristics, including age and sex, were recorded. The affected side was documented as right or left, and a detailed history was obtained regarding the mode of injury, including fall, sports-related injury, road traffic accident, or other relevant mechanisms. The injured limb was examined for swelling, deformity, tenderness, skin condition, and movement at the elbow. Particular attention was given to the neurovascular status of the affected extremity. Radial pulse, capillary refill, distal perfusion, and motor and sensory functions of the major nerves of the upper limb were assessed and documented.

Management and Outcomes of Displaced Supracondylar Humerus Fractures in Children

Radiographic evaluation was performed using appropriate anteroposterior and lateral radiographs of the elbow. The fracture was assessed for displacement, alignment, and other relevant radiological characteristics. Patients were taken up for operative management after appropriate clinical and radiological assessment.

The patient was positioned appropriately for the procedure under suitable anaesthesia. Closed reduction of the fracture was performed using controlled manipulation under image intensifier guidance. Reduction was assessed fluoroscopically in anteroposterior and lateral views. Once satisfactory alignment was obtained, the fracture was stabilized using percutaneous Kirschner wires. The wires were inserted under fluoroscopic guidance with attention to obtaining adequate purchase in the distal humeral fragments and maintaining satisfactory fracture alignment. The stability of the reduction and adequacy of K-wire placement were confirmed radiologically before completion of the procedure. The wires were secured appropriately, and suitable immobilization was applied. (Figure 1-3)



Figure 1: pre-operative x ray



Figure 2: Immediate post-operative x-ray

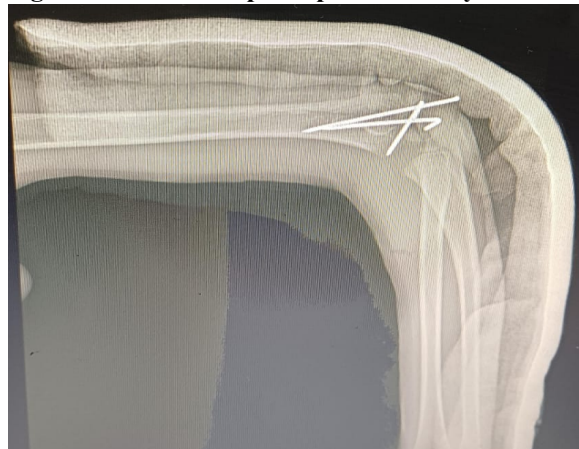


Figure 3: Post-operative day 30 x ray

Following surgery, the neurovascular status of the operated limb was reassessed and documented. Patients were monitored for postoperative complications including swelling, vascular compromise, neurological deficit, pin-site infection, and loss of fracture alignment. Patients were reviewed clinically and radiologically during follow-up. Radiographs were obtained to assess maintenance of reduction and progression of fracture healing. The K-wires were removed after sufficient clinical and radiological evidence of healing was obtained, according to the treating surgeon's assessment.

The primary outcomes assessed were anatomical and functional results following closed reduction and percutaneous K-wire fixation. Anatomical outcome was evaluated on the basis of restoration and maintenance of satisfactory fracture alignment, radiological evidence of union, and the presence or absence of residual deformity. Functional outcome was assessed by evaluating elbow range of motion, recovery of function, and return to normal activities.

Management and Outcomes of Displaced Supracondylar Humerus Fractures in Children

The operated elbow was compared with the opposite unaffected elbow wherever appropriate.

All intraoperative and postoperative complications were recorded. These included difficulties during reduction or fixation, neurovascular complications, pin-site infection, loss of reduction, malunion, elbow stiffness, and other complications encountered during the follow-up period.

Patients were followed clinically and radiologically until fracture union and satisfactory return of elbow function. At each follow-up visit, clinical examination and radiographic assessment were performed to document fracture healing, alignment, complications, range of motion, and functional recovery.

The collected data included demographic characteristics, side of involvement, mode of injury, clinical findings, radiological findings, operative details, complications, fracture union, range of motion, and functional recovery. The data were systematically recorded and analyzed using appropriate descriptive statistical methods. Quantitative variables were expressed using measures of central tendency and dispersion, while categorical variables were summarized using frequencies and percentages. Where applicable, associations between relevant variables and treatment outcomes were evaluated using appropriate statistical tests. A suitable level of statistical significance was used for inferential analysis.

Results

A total of 150 children with displaced supracondylar fractures of the humerus were included in the study. The demographic and injury-related characteristics of the study population are presented in Table 1. Male children constituted the majority of the study population (62.7%), while females accounted for 37.3%. The most commonly affected age group was 6–10 years (52.0%). The right elbow was involved in 56.7% of cases, while the left side was involved in 43.3%. The most common mode of injury was a fall while playing (54.0%).

The operative and postoperative findings are shown in Table 2. Closed reduction and percutaneous K-wire fixation were successfully performed in all 150 patients. Intraoperative complications were uncommon. Postoperative complications were observed in 18 patients (12.0%). Pin-site infection was the most frequently observed complication, occurring in 7 patients (4.7%), followed by transient neurological deficit in 4 patients (2.7%). Loss of reduction was observed in 3 patients (2.0%).

At final follow-up, radiological union was achieved in 147 patients (98.0%). Satisfactory anatomical alignment was observed in 139 patients (92.7%). Functional assessment showed excellent results in 81 patients (54.0%) and good results in 48 patients

(32.0%). Thus, 129 patients (86.0%) demonstrated excellent or good functional outcomes. Three patients had poor functional outcomes.

Table 1. Demographic and injury-related characteristics of the study population (n=150)

Serial No.	Parameter	Category	No. of patients	Percentage (%)
1	Age group	≤5 years	31	20.7
		6–10 years	78	52.0
		11–14 years	41	27.3
2	Sex	Male	94	62.7
		Female	56	37.3
3	Side involved	Right	85	56.7
		Left	65	43.3
4	Mode of injury	Fall while playing	81	54.0
		Fall from height	32	21.3
		Road traffic accident	22	14.7
		Other causes	15	10.0
5	Fracture type	Extension type	143	95.3

Management and Outcomes of Displaced Supracondylar Humerus Fractures in Children

		Flexion type	7	4.7
--	--	--------------	---	-----

Table 2. Operative and postoperative complications among the study participants (n=150)

Serial No.	Parameter	Finding	No. of patients	Percentage (%)
1	Closed reduction	Successfully achieved	150	100.0
2	Intraoperative complication	Present	3	2.0
		Absent	147	98.0
3	Postoperative complication	Present	18	12.0
		Absent	132	88.0
4	Pin-site infection	Present	7	4.7
		Absent	143	95.3
5	Neurological complication	Transient deficit	4	2.7
		No neurological complication	146	97.3

6	Vascular complication	Present	1	0.7
		Absent	149	99.3
7	Loss of reduction	Present	3	2.0
		Absent	147	98.0
8	Elbow stiffness	Present	3	2.0
		Absent	147	98.0

Table 3. Anatomical and functional outcomes at final follow-up (n=150)

Serial No.	Outcome parameter	Category	No. of patients	Percentage (%)
1	Fracture union	Achieved	147	98.0
		Delayed/non-union	3	2.0
2	Radiological alignment	Satisfactory	139	92.7
		Unsatisfactory	11	7.3
3	Residual deformity	Absent	140	93.3
		Present	10	6.7
4	Elbow range of motion	Full/near normal	131	87.3
		Restricted	19	12.7
5	Functional outcome	Excellent	81	54.0
		Good	48	32.0
		Fair	18	12.0

Management and Outcomes of Displaced Supracondylar Humerus Fractures in Children

		Poor	3	2.0
6	Return to normal activity	Yes	136	90.7
		No	14	9.3

Discussion

Supracondylar fractures of the humerus are among the most frequently encountered pediatric elbow injuries, and displaced fractures require accurate reduction and stable fixation to prevent deformity and functional impairment. In the present study, 150 children with displaced supracondylar fractures were treated by closed reduction and percutaneous K-wire fixation. The study evaluated demographic characteristics, mechanism of injury, anatomical restoration, functional recovery, fracture union, and treatment-related complications.

In the present study, males constituted 62.7% of the study population, whereas females accounted for 37.3%. The predominance of males in pediatric supracondylar fractures has also been reported in previous clinical studies and may be related to greater participation of boys in outdoor and physical activities. Children aged 6–10 years represented the largest proportion of patients in the present series (52.0%). This age distribution is clinically relevant because children in this age group are particularly active and are frequently exposed to falls and play-related injuries.

The right elbow was involved in 56.7% of cases, while 43.3% had left-sided involvement. A fall while playing was the most common mechanism of injury, accounting for 54.0% of cases. These findings are consistent with the typical mechanism of pediatric supracondylar fractures, in which a fall on the outstretched upper limb results in hyperextension and displacement at the distal humerus.

In the present study, closed reduction was successfully achieved in all 150 patients included for treatment by percutaneous fixation. The use of percutaneous K-wire fixation following closed reduction provides the advantages of maintaining fracture alignment while avoiding extensive surgical exposure. The choice and placement of K-wires are particularly important because inadequate fixation may result in loss of reduction. Skaggs et al. demonstrated that lateral-entry pin fixation can provide satisfactory stability while avoiding the potential risk of iatrogenic ulnar nerve injury associated with medial pin placement [11].

The biomechanical stability of different pin configurations has been an important consideration in

the management of displaced supracondylar fractures. Gordon et al. demonstrated that fracture stability after pinning is influenced by the configuration and placement of the pins [12]. In the present study, satisfactory radiological alignment was achieved in 92.7% of patients, suggesting that appropriate closed reduction followed by stable percutaneous fixation was effective in maintaining anatomical alignment during fracture healing.

Mazda et al. reported favorable results with systematic pinning of displaced extension-type supracondylar fractures in children and emphasized the importance of stable fixation following reduction [13]. The high proportion of satisfactory alignment observed in the present study is consistent with these findings. Stable fixation permits maintenance of reduction during the healing period and facilitates subsequent recovery of elbow motion.

Fracture union was achieved in 98.0% of patients in the present study. This high union rate indicates that closed reduction and percutaneous K-wire fixation provide an effective method for maintaining fracture stability until healing. Only a small proportion of patients demonstrated delayed or unsatisfactory healing. The high rate of union observed in the present series is consistent with the generally favorable healing potential of pediatric supracondylar fractures when satisfactory reduction and stabilization are achieved.

Functional recovery was also satisfactory. Excellent functional results were observed in 54.0% of patients and good results in 32.0%, giving an overall excellent-to-good functional outcome in 86.0% of the study population. Full or near-normal elbow range of motion was achieved in 87.3% of patients, while 90.7% returned to normal activities. These findings indicate that restoration of alignment and stable fixation were associated with good recovery of elbow function.

The overall postoperative complication rate in the present study was 12.0%. Pin-site infection was the most common complication, occurring in 4.7% of patients. Neurological complications were observed in 2.7%, vascular complications in 0.7%, loss of reduction in 2.0%, and elbow stiffness in 2.0%. These complications highlight the importance of careful reduction, appropriate K-wire positioning, postoperative monitoring, and adequate follow-up.

Skaggs et al. specifically evaluated the consequences of pin placement and emphasized that appropriate lateral-entry pinning can minimize the risk of ulnar nerve injury while providing adequate fracture stabilization [11]. Similarly, Kocher et al., in a randomized clinical trial comparing lateral-entry fixation with medial and lateral pin fixation, demonstrated that lateral-entry fixation represents an effective method of stabilization while reducing the

risk associated with medial pin placement [15]. These findings support careful selection and placement of percutaneous wires during treatment.

The present study therefore demonstrates that closed reduction and percutaneous K-wire fixation can provide satisfactory anatomical and functional outcomes in children with displaced supracondylar fractures of the humerus. The high rate of fracture union, satisfactory radiological alignment, good functional recovery, and relatively low complication rate support the use of this technique as an effective treatment modality. Nevertheless, meticulous attention to reduction, pin configuration, neurovascular assessment, and postoperative follow-up remains essential for achieving optimal results.

Conclusion

Closed reduction and percutaneous K-wire fixation is an effective and minimally invasive treatment modality for displaced supracondylar fractures of the humerus in children. In the present study of 150 patients, the procedure resulted in a high rate of fracture union, satisfactory anatomical alignment, and good functional recovery. Most children regained near-normal elbow movement and returned to their normal activities during follow-up. The incidence of complications was relatively low, with pin-site infection being the most frequently encountered complication. Proper preoperative assessment, accurate closed reduction, stable K-wire fixation, careful neurovascular monitoring, and regular postoperative follow-up are essential for achieving satisfactory anatomical and functional outcomes.

References

1. Gartland JJ. Management of supracondylar fractures of the humerus in children. *Surg Gynecol Obstet.* 1959;109(2):145-54.
2. Flynn JC, Matthews JG, Benoit RL. Blind pinning of displaced supracondylar fractures of the humerus in children. Sixteen years' experience with long-term follow-up. *J Bone Joint Surg Am.* 1974;56(2):263-72.
3. Millis MB, Singer IJ, Hall JE. Supracondylar fracture of the humerus in children. Further experience with a study in orthopaedic decision-making. *Clin Orthop Relat Res.* 1984;(188):90-7.
4. Wilkins KE. The operative management of supracondylar fractures. *Orthop Clin North Am.* 1990;21(2):269-89.
5. Furrer M, Mark G, Rüedi T. Management of displaced supracondylar fractures of the humerus in children. *Injury.* 1991;22(4):259-62.
6. Cramer KE, Devito DP, Green NE. Comparison of closed reduction and percutaneous pinning versus open reduction and percutaneous pinning in displaced supracondylar fractures of the humerus in children. *J Orthop Trauma.* 1992;6(4):407-12.
7. Zionts LE, McKellop HA, Hathaway R. Torsional strength of pin configurations used to fix supracondylar fractures of the humerus in children. *J Bone Joint Surg Am.* 1994;76(2):253-6.
8. Gordon JE, Patton CM, Luhmann SJ, Bassett GS, Schoenecker PL. Fracture stability after pinning of displaced supracondylar distal humerus fractures in children. *J Pediatr Orthop.* 2001;21(3):313-8.
9. Mehlman CT, Strub WM, Roy DR, Wall EJ, Crawford AH. The effect of surgical timing on the perioperative complications of treatment of supracondylar humeral fractures in children. *J Bone Joint Surg Am.* 2001;83(3):323-7.
10. Davis RT, Gorczyca JT, Pugh K. Supracondylar humerus fractures in children: comparison of operative treatment methods. *Clin Orthop Relat Res.* 2000;(376):49-55.
11. Skaggs DL, Hale JM, Bassett J, Kaminsky C, Kay RM, Tolo VT. Operative treatment of supracondylar fractures of the humerus in children. The consequences of pin placement. *J Bone Joint Surg Am.* 2001;83(5):735-40.
12. Gordon JE, Patton CM, Luhmann SJ, Bassett GS, Schoenecker PL. Fracture stability after pinning of displaced supracondylar distal humerus fractures in children. *J Pediatr Orthop.* 2001;21(3):313-8.
13. Mazda K, Boggione C, Fitoussi F, Penneçot GF. Systematic pinning of displaced extension-type supracondylar fractures of the humerus in children. A prospective study of 116 consecutive patients. *J Bone Joint Surg Br.* 2001;83(6):888-93.
14. Skaggs DL, Cluck MW, Mostofi A, Flynn JM, Kay RM. Lateral-entry pin fixation in the management of supracondylar fractures in children. *J Bone Joint Surg Am.* 2004;86(4):702-7.
15. Kocher MS, Kasser JR, Waters PM, Bae D, Snyder BD, Hresko MT, et al. Lateral entry compared with medial and lateral entry pin fixation for completely displaced supracondylar humeral fractures in children: a randomized clinical trial. *J Bone Joint Surg Am.* 2007;89(4):706-12.