Uludağ Üniversitesi Tıp Fakültesi Dergisi
Journal of Uludağ University Medical Faculty
52, 1757417, 2026
DOI: https://doi.org/10.32708/uutfd.1757417

ORIGINAL RESEARCH

Nerve Injuries Associated with Supracondylar Humerus Fractures: Incidence, Treatment, and Outcomes

Hakan ZORA[1], Hatice Kübra ZORA[2], Hatice ORTAÇ[3], Marzieh Karimi KHEZRİ[1], Mevlüt Özgür TAŞKAPILIOĞLU[1,4]

[1] Private Medicabil Hospital, Bursa, Türkiye.
[2] Bursa Uludağ University School of Medicine, Department of Pediatric Rheumatology, Bursa, Türkiye.
[3] Department of Biostatistics, Bursa Uludağ University, Institute of Health Sciences, Bursa, Türkiye.
[4] İstanbul Yeniyüzyıl University, School of Medicine, Department of Neurosurgery, İstanbul, Türkiye.

ABSTRACT

Supracondylar fractures of the humerus (SCHFs) are among the most common extremity fractures in the pediatric population. This study aims to assess the incidence of nerve palsies related to supracondylar humerus fractures in children. A retrospective analysis was performed of 100 pediatric patients who underwent surgical intervention for supracondylar humerus fractures at our clinic between 2021 and 2024, with available postoperative clinical follow-up data. The timing of surgery, sex, presenting symptoms, intraoperative findings, postoperative outcomes—including complications—and follow-up duration were analyzed. Of the 100 patients, 9 had preoperative nerve injuries, and 7 developed postoperative nerve injuries. All cases of postoperative nerve injury had undergone closed reduction. This study highlights that open medial pin placement during surgery may prevent iatrogenic nerve injuries. Collaborative patient management involving orthopedicians, physical therapists, and neurosurgeons can improve outcomes.

Keywords: Supracondylar humerus fracture. Nerve palsy. Neuropraxia. Complications.

Suprakondiler Humerus Kırıklarıyla İlişkili Sinir Yaralanmaları: Görülme Sıklığı, Tedavi ve Sonuçlar

ÖZET

Humerusun suprakondiler kırıkları (SCHF), pediatrik popülasyonda en sık görülen ekstremite kırıklarındandır. Bu çalışmanın amacı, çocuklarda suprakondiler humerus kırıklarıyla ilişkili sinir felci insidansını değerlendirmektir. 2021-2024 yılları arasında kliniğimizde suprakondiler humerus kırığı nedeniyle cerrahi müdahale geçiren ve mevcut postoperatif klinik takip verileri bulunan 100 pediatrik hasta retrospektif olarak analiz edildi. Ameliyat zamanlaması, cinsiyet, başvuru semptomları, intraoperatif bulgular, postoperatif sonuçlar (komplikasyonlar dahil) ve takip süresi analiz edildi. 100 hastanın 9'unda preoperatif sinir yaralanması, 7'sinde ise postoperatif sinir yaralanması gelişmişti. Postoperatif sinir yaralanması olan tüm vakalarda kapalı redüksiyon uygulanmıştı. Bu çalışma, cerrahi sırasında açık medial pin yerleştirilmesinin iatrojenik sinir yaralanmalarını önleyebileceğini vurgulamaktadır. Ortopedistler, fizyoterapistler ve beyin cerrahlarını içeren işbirlikçi hasta yönetimi sonuçları iyileştirebilir.

Anahtar Kelimeler: Suprakondiler humerus kırığı. Sinir felci. Nöropraksi. Komplikasyon.

Date Received: 11.August.2025
Date Accepted: 9.March.2026

Dr. Mevlüt Özgür TAŞKAPILIOĞLU
Özel Medicabil Hastanesi Beyin ve Sinir Cerrahisi Bölümü,
Mudanya Yolu Fethiye Mh. Küre Sk.No: 1 Nilüfer,
Bursa
E-posta: mozgurt@gmail.com

AUTHORS' ORCID INFORMATION
Hakan ZORA: 0000-0002-5323-8245
Hatice Kübra ZORA: 0000-0001-8178-8386
Hatice ORTAÇ: 0000-0002-1199-1706
Marzieh Karimi KHEZRİ: 0000-0002-6397-0966
Mevlüt Özgür TAŞKAPILIOĞLU: 0000-0001-5472-9065

Supracondylar fractures of the humerus (SCHFs) are among the most common extremity fractures in the pediatric population, representing the most common type of fractures involving the elbow joint in this age group[1,2]. The Gartland's classification system is widely used to evaluate the severity of these fractures[3]. The treatment of these fractures can be complicated by associated factors, including arterial and peripheral nerve injuries, as well as inadequate union[4,5], which may arise from the initial trauma or develop as treatment complications[6]. Iatrogenic nerve injuries in SCHFs most frequently affect the ulnar nerve. This is often associated with closed reduction and fixation using Kirschner wires (K-wires), a common treatment for displaced fractures[7,8]. To minimize the risk of iatrogenic nerve injury, some

orthopedic surgeons use mini-open surgical techniques, particularly during medial pin placement, which allow protection of the ulnar nerve through a limited skin incision with direct visualization[8.] Specifically, ulnar nerve injury usually occurs during median pin insertion[8,9]. Median nerve injury, particularly to the anterior interosseus nerve, is more likely with posterolateral displacement, while radial nerve injury occurs due to posteromedial displacement[4,5]. Additional factors contributing to nerve injury include post-traumatic and postoperative tissue edema, traction injury during manipulation, and callus formation[10-13]. While nerve injury often heals spontaneously, delayed treatment can lead to permanent deficits[14].

Our hospital, a referral center for orthopedic care, caters to approximately 4000 patients every year. This study aimed to investigate the incidence and characteristics of post-traumatic peripheral nerve injuries in children with SCHFs.

Materials and Methods

This retrospective, observational, single-center cohort study was approved by the institutional research committee (Date: 07.01.2025, Decision Number 2025/01-1439). Written informed consent was obtained from the parents or legal guardians of all pediatric patients enrolled in the study.

We reviewed the clinical records of all pediatric patients with dislocated SCHFs treated at our hospital between January 2021 and January 2024. Exclusion criteria included: previous osteosynthesis of supracondylar fracture at another institution, multiple fractures in the same extremity, history of previous fractures in the same extremity, and presence of additional neurological diseases. All patients were preoperatively assessed by a trauma surgeon, including X-ray studies of the fractures. Fractures were classified using the modified Gartland classification system (Table I), and outcomes were evaluated using the Mayo Elbow Performance Score (MEPS) (Table II).

Table I. Modified Gartland classification system

Fracture type	Characteristics
I	Undisplaced fracture
II	Displaced with intact posterior cortex
III	Completely displaced—either posteromedial IIIA or posterolateral IIIB
IV	Multidirectional instability with circumferential periosteal disruption

Table II. Mayo Elbow Performance Scoring system (4)

Variable	Definition	Points
Pain	None	45
	Mild	30
	Moderate	15
	Severe	0
Range of motion, degrees	Arc>100	20
	Arc 50-100	15
	Arc <50	5
Stability	Stable	10
	Moderately unstable	5
	Grossly unstable	0
Function	Comb hair	5
	Feed	5
	Hygiene	5
	Shirt	5
	Shoe	5

Surgical techniques for osteosynthesis were selected by the treating trauma surgeon based on the indications. Typically, K-wires were removed one month after surgery. K-wire placement was performed under fluoroscopic guidance. A check x-ray was performed postoperatively to assess fracture reduction and correct placement of K-wires. Postoperative neurological examinations were performed by orthopedic surgeons. All patients were called for outpatient follow-up after 3 days to monitor for complications such as compartment syndrome. Subsequently, they were followed weekly until K-wire removal, after which rehabilitation began. The minimum postoperative follow-up period was 3 months, extending up to 12 months if complications or nerve injuries occurred.

Statistical Analysis

The normality of continuous variables was assessed using the Shapiro-Wilk test. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequency (percentage). The Kruskal-Wallis test was used when the number of groups was greater than two and the normality assumption was not met. Categorical variables were compared between groups using the Fisher-Freeman-Halton test. Statistical analyses were performed using SPSS (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, version 25.0. Armonk, NY: IBM Corp.). P-values <0.05 were considered indicative of statistical significance.

Results

A total of 100 pediatric patients (53 males, 47 females) were treated during the study reference period. The average age was 7.27±2.87 years (range, 4–16). The distribution of injuries by affected side

showed that 41% of cases involved the right side and 59% involved the left side. According to fracture type classification, 37% of patients had 3A fracture types, 50% had type 3B fractures, and 13% had type 4 fractures. Only one case had an accompanying vascular injury. The patient characteristics are summarized in Table III.

Table III. Characteristics of the study population

	Mean ± Standard Deviation
Age (years)	7.27 ± 2.87
	n (%)
Sex	
Male	53 (53%)
Female	47 (47%)
Side	
Right	41 (41%)
Left	59 (59%)
Fracture type	
3A	37 (37%)
3B	50 (50%)
4	13 (13%)

Data expressed as mean ± standard deviation or n (%)

The median age of patients by fracture type was 6 years (range 4–16) for type 3A, 6 years (range, 5–16) for type 3B, and 7 years (range, 5–15) for type 4. There was no significant difference in age distribution between fracture types (p=0.392).

All fractures were treated with cross fixation using K-wires under general anesthesia. A closed reduction was performed in 94% of patients, while 6% required open reduction. K-wires were removed 4 weeks postoperatively. A two-week rehabilitation program was conducted at the physical therapy clinic. Preoperative nerve damage assessment showed no nerve damage in 91% of patients, whereas 5% had ulnar nerve damage, 2% had median nerve damage, 1% had radial nerve damage, and 1% had both median and radial nerve damage. Postoperatively, 93 patients had no nerve damage, while 7 developed new peripheral nerve injuries. Ulnar nerve injury was most common (6%, n=6), followed by median nerve injury in 2 patients and radial nerve injury in 1 patient. A significant association was found between surgical technique and postoperative nerve injury (p<0.001) (Tables IV and V). Subgroup analyses revealed that all six patients with postoperative ulnar nerve injury had undergone closed reduction and percutaneous pinning, whereas no postoperative ulnar nerve injury occurred with the medial mini-open approach or open reduction with percutaneous pinning (p<0.001).

No combined postoperative nerve deficits were observed. Patients were followed clinically without electroneuromyography or nerve conduction studies. Five patients underwent early postoperative exploration, and median pin irritation was detected, prompting pin revision. Two patients underwent exploration 6 weeks postoperatively, revealing nerve compression at the fracture line, and underwent ulnar nerve decompression. All patients showed complete recovery at 12 weeks postoperatively.

Table IV. Incidence of postoperative nerve injury by surgery type

	Postoperative Nerve Injury		p value
	Absent n (%)	Present n (%)	
Surgery Type			
Open reduction with pin fixation	6 (6.5%)	0	**<0.001[a]**
Closed reduction with pin fixation	8 (8.6%)	6 (85.7%)	
Closed reduction with medial mini-open incision and pin fixation	79 (84.9%)	1 (14.3%)	

Data presented as n (%)
[a]Fisher-Freeman-Halton test

Table V. Distribution of nerve injury by surgery type

	Postoperative Nerve Injury			
Surgery Type	**None**	**Ulnar**	**Median**	**p-value**
Open reduction with pin fixation	6 (6.5%)	0	0	**<0.001[a]**
Closed reduction with pin fixation	8 (8.6%)	6 (100%)	0	
Closed reduction with medial mini-open incision and pin fixation	79 (84.9%)	0	1(100%)	

Data presented as n (%)
[a]Fisher-Freeman-Halton test

The mean MEPS in our cohort was 93.3±6.75. According to the Mayo classification, outcomes were excellent in 83% of patients, good in 16%, and moderate in 1% (Table VI).

Table VI.

	n (%)
Mayo Elbow Performance Score (MEPS)	93.3 ± 6.75
Mayo Classification	
Excellent	83 (83%)
Good	16 (16%)
Moderate	1 (1%)
Preop Nerve Injury	
No injury	91 (91%)
Ulnar	5 (5%)
Median	2 (2%)
Radial	1 (1%)
Median+Radial	1 (1%)
Postop Nerve Injury	
No injury	93 (93%)
Ulnar	6 (6%)
Median	1 (1%)

Data expressed as mean ± SD or n (%).

Discussion and Conclusıın

Peripheral nerve damage due to supracondylar fractures occurs in approximately 12% of cases[6], with some series reporting rates up to 16%. The ulnar nerve was the most commonly injured nerve in our cohort, consistent with findings by Kwok et al.[11] and Chrenko et al.[6]. Supracondylar fractures typically occur between the ages of 5 and 8, and the mean age of 7.2 years in our cohort aligns with the literature[15].

Closed reduction and percutaneous pinning are considered the standard surgical approach for displaced SCHFs, although there is no universally accepted treatment protocol[15,16]. In the present study, the incidence of nerve palsy in type III fractures (19.3%) was significantly higher compared to type II (0.9%). This finding is consistent with rates observed in a large series (n=709) reported by Oetgen et al. (perioperative nerve palsy rates of 12.1% and 1.5%, respectively)[17].

Nerve injury in SCHFs may develop depending on the trauma mechanism and the displacement of humeral fragments. The ulnar nerve is particularly vulnerable to intraoperative injury during medial closed pinning. Postoperative ulnar nerve injury may result from direct pin irritation or callus formation compressing the nerve. Many surgeons prefer percutaneous pinning with a cross-pin configuration, as it provides the greatest mechanical stability[18-21]. The rates of iatrogenic ulnar nerve injury vary depending on the surgical technique employed. These rates have been reported in studies utilizing methods such as blind identification and manipulation of the nerve[22-24], intraoperative nerve monitoring electrodes[25], and ultrasound guidance[26]. Most of the studies reporting the lowest rates of ulnar nerve injury involved the use of mini-open techniques enabling direct visualization of the nerve[18-20,27,28]. In the present study, all six cases of postoperative ulnar nerve injury occurred with blind pinning after nerve identification by palpation. In contrast, no iatrogenic nerve injuries occurred in patients who underwent medial mini-open technique or open reduction. This finding aligns with Rees et al.'s 2018 study, which reported the mini-open technique as a safe method for minimizing iatrogenic ulnar nerve injury[29]. Our findings suggest that using the medial mini-open technique for pinning may reduce the risk of nerve injury, consistent with the literature.

In the literature and clinical practice, most nerve injuries following SCHFs are managed conservatively, assuming a temporary neurapraxia. However, the duration of this management strategy, follow-up protocols, and treatment response criteria are unclear[30-32]. For cases involving cross-pinning and postoperative iatrogenic ulnar nerve palsy, there is no consensus on management[33]. Some authors[8,34] recommend clinical observation and a conservative approach, while others suggest early wire removal[35,36], repositioning and/or surgical exploration[37,38] of the ulnar nerve. In our study, all patients with postoperative iatrogenic ulnar nerve palsy underwent early surgical exploration. The main reason for this approach was that, in all of these cases, medial pinning had been performed using a percutaneous technique without direct visualization of the ulnar nerve. This situation increases the likelihood of direct pin irritation, compression, or transfixation of the nerve, thereby making early surgical exploration a more rational option than conservative observation. Accordingly, postoperative ulnar nerve palsies observed in our study cohort were not managed conservatively under the assumption of simple neurapraxia; instead, early surgical intervention was preferred to rule out potential mechanical causes. Non-operated cases involving nerves other than the ulnar nerve showed improvement in nerve function within an mean of 4 weeks. Our study suggests that, in cases of ulnar nerve palsy following percutaneous medial pinning, early surgical exploration may represent a clinically safe and rational option compared to conservative observation, allowing for the early assessment of potential mechanical causes. Considering that all patients who developed postoperative ulnar nerve palsy underwent percutaneous pinning without direct visualization of the nerve, this approach appears to be potentially unsafe and may increase the risk of iatrogenic nerve injury.

Functional outcomes are a key indicator of treatment success for SCHFs. A previous study evaluated 80 patients who underwent surgical treatment for these fractures and reported MEPS results of 94.7% excellent, 4% good, and 1.3% fair[39]. Another study by Pavone et al. compared two different pinning configurations in the surgical treatment of these fractures, with MEPS results of 98 in the lateral pinning group and 96 in the crossed pinning group[40]. In our study, we found the mean MEPS was 93.3±6.75. When categorized, our results were consistent with the literature, with 83% of cases rated as excellent, 16% as good, and 1% as moderate.

Peripheral nerve injuries associated with SCHFs in children are common and may result from both the initial trauma and surgical intervention. While many nerve injuries recover spontaneously, iatrogenic damage during surgery can lead to permanent functional deficits. As demonstrated in this study, the medial mini-open technique, allowing direct nerve visualization, significantly reduces the risk of ulnar nerve injuries compared to blind pinning methods. Our findings align with previous studies[19,29,41]. Graff et al. reported that nerve injuries tend to heal

spontaneously within the first four months, but recommended surgical intervention for patients who do not show recovery within this time frame[33].

The main limitations of this study include the relatively small sample size and its single-center design, which may limit the generalizability of the findings. Larger multicenter, prospective studies are required to generate more robust evidence. Additionally, conducting thorough neurological examinations in pediatric patients can be challenging, potentially affecting the accuracy of nerve injury assessments. One of the important methodological limitations of this study is the absence of electrodiagnostic evaluations, such as electromyography (EMG) and nerve conduction studies, which limited the objective and accurate assessment of nerve injuries. Furthermore, the absence of radiological measurement analysis restricted a more detailed evaluation of anatomical alignment and potential structural abnormalities. Future studies should employ standardized electrophysiological tests like EMG during follow-up of nerve injuries to provide more objective data regarding the type and progression of nerve recovery. Additionally, randomized controlled trials comparing different pinning techniques would help inform clearer surgical guidelines.

Open medial pin placement during surgery may prevent iatrogenic nerve injuries in pediatric patients with SCHFs. A multidisciplinary approach involving orthopedic surgeons, physical therapists, and neurosurgeons can optimize outcomes in these patients. Meticulous neurological assessment, appropriate surgical technique selection, and interdisciplinary collaboration should be considered essential components of pediatric SCHF management.

Researcher Contribution Statement:
Idea and design: M.Ö.T.; Data collection and processing: H.Z, M.K.K., K.Z.; Analysis and interpretation of data: H.O; Writing of significant parts of the article: H.Z., M.Ö.T., K.Z.; Critical revision of the article: H.Z., M.Ö.T, M.K.K.
Support and Acknowledgement Statement:
None
Conflict of Interest Statement:
--The authors of the article have no conflict of interest declarations.
Ethics Committee Approval Information:
Approving Committee: İstanbul Yeni Yüzyıl Üniversitesi Etik Kurulu
Approval Date: 07.01.2025
Decision No: 2025/01-1439

References

1. Schneidmueller D, Boettger M, Laurer H, Gutsfeld P, Bühren V. Distal humerus fractures in children. Der Orthopäde. 2013;42: 977-85.
2. Vaquero-Picado A, González-Morán G, Moraleda L. Management of supracondylar fractures of the humerus in children. EFORT Open Rev. 2018;3: 526-540.
3. Gartland JJ. Management of supracondylar fractures of the humerus in children. Surg Gynecol Obstet. 1959;109: 145-154.
4. Campbell CC, Waters PM, Emans JB, Kasser JR, Millis MB. Neurovascular injury and displacement in type III supracondylar humerus fractures. J Pediatr Orthop. 1995;15: 47-52.
5. Wang SI, Kwon TY, Hwang HP, Kim JR. Functional outcomes of Gartland III supracondylar humerus fractures with early neurovascular complications in children: A retrospective observational study. Medicine. 2017;96: e7148.
6. Chrenko R, Hanko M, Grega M, Sýkora Ľ, Jáger R. Peripheral nerve injuries associated with dislocated supracondylar fractures of distal humerus in children: Incidence and need of surgical treatment. Childs Nerv Syst. 2024;40: 3771-3776.
7. Joiner ERA, Skaggs DL, Arkader A, et al. Iatrogenic nerve injuries in the treatment of supracondylar humerus fractures: Are we really just missing nerve injuries on preoperative examination? J Pediatr Orthop. 2014;34: 388-392.
8. Kalenderer O, Reisoglu A, Surer L, Agus H. How should one treat iatrogenic ulnar injury after closed reduction and percutaneous pinning of paediatric supracondylar humeral fractures? Injury. 2008;39: 463-466.
9. Lyons JP, Ashley E, Hoffer MM. Ulnar nerve palsies after percutaneous cross-pinning of supracondylar fractures in children's elbows. J Pediatr Orthop. 1998;18: 43-45.
10. Gosens T, Bongers KJ. Neurovascular complications and functional outcome in displaced supracondylar fractures of the humerus in children. Injury. 2003;34: 267-273.
11. Kwok IH, Silk ZM, Quick TJ, et al. Nerve injuries associated with supracondylar fractures of the humerus in children: Our experience in a specialist peripheral nerve injury unit. Bone Joint J. 2016;98-B: 851-856.
12. Ramachandran M, Birch R, Eastwood DM. Clinical outcome of nerve injuries associated with supracondylar fractures of the humerus in children: The experience of a specialist referral centre. J Bone Joint Surg Br. 2006;88: 90-94.
13. Štichhauer R, Preis J, Kanta M, Krobot J. Poranění periferních nervů při suprakondylických zlomeninách humeru u dětí. Česká Slov Neurol Neurochir. 2017;80: 440.
14. Iobst CA, Spurdle C, King WF, Lopez M. Percutaneous pinning of pediatric supracondylar humerus fractures with the semisterile technique: The Miami experience. J Pediatr Orthop. 2007;27: 17-22.
15. Norrell KN, Muolo CE, Sherman AK, Sinclair MK. The frequency and outcomes of nerve palsies in operatively treated supracondylar humerus fractures. J Pediatr Orthop. 2022;42: 408-412.
16. Basques BA, Lukasiewicz AM, Samuel AM, et al. Which pediatric orthopaedic procedures have the greatest risk of adverse outcomes? J Pediatr Orthop. 2017;37: 429-434.
17. Oetgen ME, Mirick GE, Atwater L, Lovejoy JF. Complications and predictors of need for return to the operating room in the treatment of supracondylar humerus fractures in children. Open Orthop J. 2015;9: 139-142.
18. 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: 313-318.
19. Green DW, Widmann RF, Frank JS, Gardner MJ. Low incidence of ulnar nerve injury with crossed pin placement for pediatric supracondylar humerus fractures using a mini-open technique. J Orthop Trauma. 2005;19: 158-163.
20. Kocher MS, Kasser JR, Waters PM, 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: 706-712.

21. Lee SS, Mahar AT, Miesen D, Newton PO. Displaced pediatric supracondylar humerus fractures: Biomechanical analysis of percutaneous pinning techniques. J Pediatr Orthop. 2002;22: 440-443.
22. Bashyal RK, Chu JY, Schoenecker PL, et al. Complications after pinning of supracondylar distal humerus fractures. J Pediatr Orthop. 2009; 29: 704-708.
23. Prashant K, Lakhotia D, Bhattacharyya TD, Mahanta AK, Ravoof A. A comparative study of two percutaneous pinning techniques (lateral vs medial–lateral) for Gartland type III pediatric supracondylar fracture of the humerus. J Orthop Traumatol. 2016;17: 223-229.
24. Shim JS, Lee YS. Treatment of completely displaced supracondylar fracture of the humerus in children by cross-fixation with three Kirschner wires. J Pediatr Orthop. 2002;22: 12-16.
25. Shtarker H, Elboim-Gabyzon M, Bathish E, et al. Ulnar nerve monitoring during percutaneous pinning of supracondylar fractures in children. J Pediatr Orthop. 2014;34: 161-165.
26. Soldado F, Knorr J, Haddad S, et al. Ultrasound-guided percutaneous medial pinning of pediatric supracondylar humeral fractures to avoid ulnar nerve injury. Arch Bone Jt Surg. 2015;3: 169-172.
27. Maity A, Saha D, Roy DS. A prospective randomised, controlled clinical trial comparing medial and lateral entry pinning with lateral entry pinning for percutaneous fixation of displaced extension type supracondylar fractures of the humerus in children. J Orthop Surg Res. 2012;7: 6.
28. Woo CY, Ho HL, Ashik MBZ, Lim KBL. Paediatric supracondylar humeral fractures: A technique for safe medial pin passage with zero incidence of iatrogenic ulnar nerve injury. Singapore Med J. 2018;59: 94-97.
29. Rees AB, Schultz JD, Wollenman LC, et al. A mini-open approach to medial pinning in pediatric supracondylar humeral fractures may be safer than previously thought. J Bone Joint Surg Am. 2022;104: 33-40.
30. Brown IC, Zinar DM. Traumatic and iatrogenic neurological complications after supracondylar humerus fractures in children. J Pediatr Orthop. 1995;15: 440-443.
31. Cramer KE, Green NE, Devito DP. Incidence of anterior interosseous nerve palsy in supracondylar humerus fractures in children. J Pediatr Orthop. 1993;13: 502-505.
32. Tomaszewski R, Gap A, Wozowicz A, Wysocka P. Analysis of early vascular and neurological complications of supracondylar humerus fractures in children. Pol Orthop Traumatol 2012;77: 101-104.
33. Graff C, Dounas GD, Todd MRLC, Sung J, Kumawat M. Management of traumatic nerve palsies in paediatric supracondylar humerus fractures: A systematic review. Children (Basel). 2023;10: 1862.
34. Khademolhosseini M, Abd Rashid AH, Ibrahim S. Nerve injuries in supracondylar fractures of the humerus in children: Is nerve exploration indicated? J Pediatr Orthop B. 2013;22: 123-126.
35. Royce RO, Dutkowsky JP, Kasser JR, Rand FR. Neurologic complications after K-wire fixation of supracondylar humerus fractures in children. J Pediatr Orthop. 1991;11: 191-194.
36. Weinberg M, Weinberg MJ, Al-Qattan MM, Zuker RM, Cole WG. Ulnar nerve injuries from percutaneous pinning of supracondylar fractures of the humerus in children. J Orthop Surg-Hong Kong. 1995;3: 55-58.
37. Ikram MA. Ulnar nerve palsy: A complication following percutaneous fixation of supracondylar fractures of the humerus in children. Injury. 1996;27: 303-305.
38. Rasool MN. Ulnar nerve injury after K-wire fixation of supracondylar humerus fractures in children J Pediatr Orthop. 1998;18: 686-690.
39. Zaman SU, Julfikar A, Islam Nissan MNI. Supracondylar humerus fracture in children: A retrospective study. Med Today. 2025;37: 88-92.
40. Pavone V, Riccioli M, Testa G, et al. Surgical treatment of displaced supracondylar pediatric humerus fractures: Comparison of two pinning techniques. J Funct Morphol Kinesiol. 2016;1: 39-47.
41. Su Y, Nan G. Evaluation of a better approach for open reduction of severe Gartland type III supracondylar humeral fracture. J Invest Surg. 2021;34: 479-485.