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Research

Evaluating Surgical Outcomes of Supracondylar Humerus Fractures Through Patient and Parent Perspectives

Suprakondiler Humerus Kırıklarının Cerrahi Sonuçlarının Hasta ve Ebeveyn Perspektifinden Değerlendirilmesi

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ABSTRACT

Objective: This study aimed to evaluate the surgical outcomes of supracondylar humerus (SCH) fractures in children aged 8-18 years, focusing on patient and parental satisfaction.

Methods: A retrospective analysis was conducted on 105 pediatric patients (81 male and 24 female) treated surgically between 2018 and 2025. Data collected included demographic characteristics, fracture classification (Gartland), reduction type, surgical method, Baumann angle, capitellohumeral angle, healing time, follow-up duration, Visual Analog Scale (VAS) scores, Pediatric Quality of Life Inventory (PedsQL) scores, Client Satisfaction Questionnaire-8 (CSQ-8) scores, Flynn cosmetic and functional criteria, and complications. Subgroup analyses were performed to assess differences based on fracture classification and reduction type.

Results: The mean age of the patients was 10.16±1.9 years. Gartland type 2 fractures demonstrated significantly shorter healing times compared to type 3 fractures (p=0.05), and closed reductions were associated with shorter healing times than open reductions (p=0.04). Although PedsQL scores, were higher in Gartland type 2 fractures (95.3±8) and closed reductions (94.9±8.1) compared to type 3 fractures (93.8±8.4) and open reductions (92.4±9.1), these differences were not statistically significant. Subgroup analysis revealed significant associations between CSQ-8 scores and the presence of concomitant injuries (p=0.03) as well as the need for revision surgeries (p=0.028). Overall, surgical outcomes were satisfactory, with high PedsQL and low VAS scores across all groups.

Conclusion: Patient and parental satisfaction in SCH fracture treatment is influenced by concomitant injuries and revision surgery, despite generally favorable surgical outcomes.

Keywords: Supracondylar humerus fractures, pediatric trauma, patient and parental satisfaction

ÖZ

Amaç: Bu çalışmada, 8-18 yaş arası çocuklarda suprakondiler humerus (SKH) kırıklarının cerrahi sonuçlarının hasta ve ebeveyn memnuniyeti ile olan ilişkisi incelenmiştir.

Gereç ve Yöntem: 2018-2025 yılları arasında cerrahi olarak tedavi edilen 105 pediatrik hasta (81 erkek, 24 kız) üzerinde retrospektif bir analiz yapıldı. Toplanan veriler arasında demografik özellikler, kırık sınıflaması (Gartland), redüksiyon türü, cerrahi yöntem, Baumann açısı, kapitellohumeral açı, kaynama süresi, takip süresi, Görsel Analog Skala (GAS) skorları, Çocuk Yaşam Kalitesi Envanteri (PedsQL) skorları, Hasta Memnuniyeti Anketi-8 (CSQ-8) skorları, Flynn kozmetik ve fonksiyonel kriterleri ile komplikasyonlar yer aldı. Alt grup analizleri, kırık sınıflamasına ve redüksiyon türüne göre farklılıkları değerlendirmek için gerçekleştirildi.

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Bulgular: Hastaların ortalama yaşı 10,16±1,9 yıl idi. Gartland tip 2 kırıklarında, tip 3 kırıklara kıyasla anlamlı derecede daha kısa kaynama süreleri gözlendi (p=0,05) ve kapalı redüksiyon uygulanan hastalarda açık redüksiyon yapılanlara kıyasla kaynama süreleri daha kısa bulundu (p=0,04). Gartland tip 2 kırıklarında (95,3±8) ve kapalı redüksiyon uygulanan hastalarda (94,9±8,1) PedsQL skorları, tip 3 kırıklar (93,8±8,4) ve açık redüksiyon (92,4±9,1) ile karşılaştırıldığında daha yüksek olmasına rağmen, bu farklılıklar istatistiksel olarak anlamlı değildi. Alt grup analizi, CSQ-8 skorlarının eşlik eden yaralanmaların varlığı (p=0,03) ve revizyon cerrahisi ihtiyacı (p=0,028) ile anlamlı ilişkili olduğunu ortaya koydu. Genel olarak, tüm gruplarda yüksek PedsQL ve düşük GAS skorları ile cerrahi sonuçlar tatmin edici bulundu.

Sonuç: SKH kırıklarının cerrahi tedavisinde hasta ve ebeveyn memnuniyeti, genellikle olumlu sonuçlara rağmen, eşlik eden yaralanmalar ve revizyon cerrahisi ihtiyacından etkilenmektedir.

Anahtar Kelimeler: Suprakondiler humerus kırıkları, pediatrik travma, hasta ve ebeveyn memnuniyeti

INTRODUCTION

Supracondylar humerus (SCH) fractures are among the most common elbow injuries in the pediatric population (1). These fractures typically occur due to mechanisms such as falls, trauma, or high-energy impacts, and require careful management due to their potential to cause serious neurovascular complications (2). The primary goals in the treatment of SCH fractures are to restore fracture stability, protect neurovascular structures, and optimize functional recovery (3).

The choice of treatment is generally determined by the type and severity of the fracture. According to the Gartland classification, type 1 fractures can often be managed conservatively, whereas type 2 and type 3 fractures typically require surgical intervention. Closed reduction and percutaneous pinning are considered the gold standard for the surgical management of these fractures, while open reduction and internal fixation are reserved for more complex fractures or cases where closed reduction fails (4).

The literature has explored the relationship between different fracture types, treatment outcomes, and patient satisfaction, focusing on patient perspectives and cosmetic results (5-9). However, studies evaluating the relationship between both the surgical treatment of SCH fractures and patient and parental satisfaction, as well as cosmetic outcomes, remain limited.

This study aims to evaluate the radiological, clinical, and cosmetic outcomes of the surgical treatment of SCH fractures. Additionally, it seeks to assess treatment outcomes from the perspectives of patients and their parents, and to investigate the associations between these outcomes and variables such as fracture type and treatment method.

METHODS

Study Design and Setting

This retrospective, single-center study evaluated pediatric patients who underwent surgical treatment for SCH fractures between 2018 and 2025. Ethical approval for the study was obtained from the Clinical Research Ethics Committee of the University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital (approval no: 2021-04-12, date: 15.02.2021).

Inclusion and Exclusion Criteria

The study included pediatric patients aged 8 to 18 years who presented with SCH fractures, underwent surgical treatment, and completed a minimum follow-up of 24 months at our institution. Patients capable of completing the Pediatric Quality of Life Inventory (PedsQL) questionnaire were eligible for inclusion. Exclusion criteria were incomplete medical records, follow-up at external institutions, pre-existing upper extremity deformities, metabolic bone disorders, or pathological fractures. A total of 105 patients who met the inclusion criteria were included in the analysis.

Data Collection

Demographic data (age, sex, injured side, dominant side, and mechanism of injury) were collected directly from patients during outpatient visits and confirmed using electronic medical records. Associated injuries (vascular injury, neurological injury, compartment syndrome), mechanisms of injury, and fracture classification based on the Gartland system were documented. Surgical treatment details (open or closed reduction, fixation method) and complications during or after surgery were recorded. Radiological outcomes, including Baumann angle and capitellohumeral angle, were assessed using the most recent radiographs obtained during follow-up. Clinical outcomes such as healing time, follow-up duration, and Visual Analog Scale (VAS) scores were also evaluated.

Surgical Technique

Under general anesthesia, patients were positioned supine, and pneumatic tourniquets were applied to control blood flow and ensure optimal surgical conditions. Closed reduction and percutaneous pinning were initially attempted in all cases. In successful closed reductions, fixation was achieved using crossed K-wires inserted laterally and/or medially, depending on fracture configuration. For cases where closed reduction was unsuccessful, the pneumatic tourniquet was inflated and a lateral mini-incision was made

for open reduction. Fixation was subsequently achieved using crossed K-wires, similar to the closed reduction group. At the end of the surgical procedure, a long-arm splint was applied to all patients (Figure 1).

Postoperative Care

Patients were monitored with a standard analgesia protocol during hospitalization. Depending on pain levels and soft tissue conditions, they were discharged within 24 to 48 hours postoperatively. All patients were called for a follow-up visit at the second postoperative week. For those who underwent open reduction, sutures were removed during this visit. At the fourth postoperative week, K-wires were removed, and passive and active range-of-motion exercises, as well as strengthening exercises, were initiated. Follow-up visits were scheduled at the second, third, sixth, and twelfth months postoperatively and annually thereafter. During the final follow-up visit, patient satisfaction was evaluated using PedsQL scores, and parental satisfaction was assessed using Client Satisfaction Questionnaire-8 (CSQ-8) scores. Additionally, objective cosmetic and functional outcomes were evaluated using Flynn cosmetic and functional criteria, and radiological outcomes were assessed by measuring the Baumann and capitellohumeral angles (Figure 2).

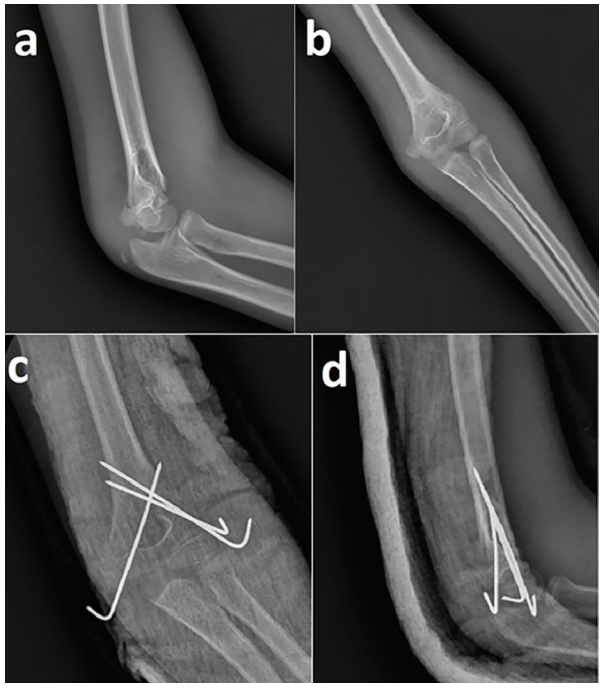

Figure 1. Preoperative and postoperative radiographic images of a 9-year-old male patient with a Gartland type 3 supracondylar humerus fracture. (a) Preoperative lateral elbow X-ray. (b) Preoperative anteroposterior (AP) elbow X-ray. (c) Postoperative AP elbow X-ray showing closed reduction and fixation with two lateral and one medial K-wire. (d) Postoperative lateral elbow X-ray

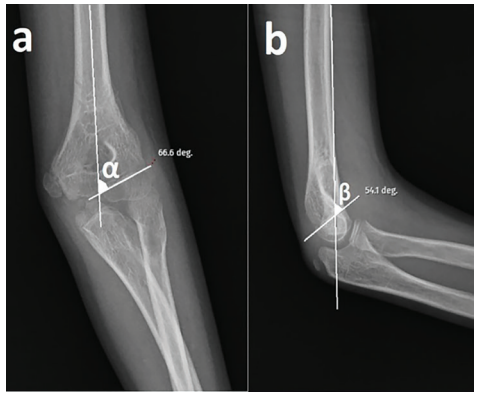

Figure 2. Anteroposterior (AP) and lateral elbow X-rays of the same patient taken at the 2-year follow-up. (a) Measurement of the Baumann angle on the AP elbow X-ray. (b) Measurement of the capitellohumeral angle on the lateral elbow X-ray

Primary and Secondary Outcomes

The primary outcomes of this study were healing time, radiological results (Baumann angle and capitellohumeral angle), patient satisfaction measured using PedsQL scores, and parental satisfaction evaluated using CSQ-8 scores. Secondary outcomes included functional and cosmetic results assessed using Flynn criteria, the occurrence of complications, the need for revision surgeries, and postoperative pain levels based on VAS scores. Additionally, correlations between CSQ-8, PedsQL, and Flynn criteria were analyzed to explore their interrelationships.

Statistical Analysis

Statistical analysis was performed using IBM SPSS 26 (Chicago, IL, USA). Descriptive statistical methods (minimum, maximum, and median values) were used to evaluate the study data. The normality of quantitative data was tested using the Kolmogorov-Smirnov test and graphical examinations. Independent sample t-tests were used to compare normally distributed quantitative variables between two groups, while the chi-square test was employed for qualitative independent data. A p-value of <0.05 was considered statistically significant.

RESULT

The demographic characteristics of the patients are summarized in Table 1. A total of 105 patients, aged 8-15 years, were included in the study (24 females and 81 males). Subgroup analyses based on fracture types and reduction methods revealed no statistically significant differences in Baumann angle, capitellohumeral angle, follow-up duration, or VAS scores among the groups ($p>0.05$). However, healing time was significantly shorter in Gartland type 2 fractures compared to type 3 fractures ($p=0.05$); and in cases treated

with closed reduction compared to open reduction (p=0.04).

The mean PedsQL scores were higher in Gartland type 2 fractures (95.3±8) compared to type 3 fractures (93.8±8.4), but this difference was not statistically significant (p>0.05). Similarly, PedsQL scores were higher in cases treated with closed reduction (94.9±8.1) compared to open reduction (92.4±9.1), but the difference was not statistically significant (p>0.05) (Table 2).

According to the Flynn criteria, there were no statistically significant differences in fracture classification, reduction type, or sex (p>0.05). When CSQ-8 scores were categorized into three subgroups, no statistically significant differences were found among dominant side, mechanism of injury, Gartland classification, surgical method, or sex (p>0.05) (Table 3). However, subgroup analysis based on CSQ-8 scores revealed a statistically significant difference between the intermediate and high CSQ-8 groups in terms of the presence of associated injuries (p=0.03). Similarly, revision surgeries were significantly more common in the intermediate CSQ-8 group compared to the high CSQ-8 group (p=0.028).

Key Findings

1) Healing time was shorter in cases of Gartland type 2 fractures and in cases treated with closed reduction.

2) Mean PedsQL scores were higher in Gartland type 2 fractures and cases treated with closed reduction, although the differences were not statistically significant.

3) Patients with associated injuries were significantly more common in the intermediate CSQ-8 group compared to the high CSQ-8 group.

4) Revision surgeries were significantly more frequent in the intermediate CSQ-8 group compared to the high CSQ-8 group.

Table 1. Demographic distribution of the patients

Parameter	**Mean±SD**	**Median**	**Min-Max**
Age	10.16±1.957	9	8-15
Baumann angle	72.87±5.654	73	59-85
Capitellohumeral angle	44.87±5.987	44	35-63
Healing time (weeks)	3.75±0.568	4	3-5
Follow-up duration (months)	34.74±8.780	32	24-60
VAS score	0.28±0.628	0	0-3
PedsQL score	94.54±8.289	98	71-100
CSQ-8 score	26.48±4.641	28	12-32
CSQ-8 mean score	2.59±0.567	3	1-3
Variable			**n (%)**
Gartland classification	Type 2		50 (47.6%)
	Type 3		55 (52.4%)
Surgical approach	Open		17 (16.1%)
	Closed		88 (83.9%)
Associated injuries	Vascular injury		0
	Nerve injury		7 (6.6%)
Gender	Male		81 (77.1%)
	Female		24 (22.9%)
Affected side	Right		57 (54.3%)
	Left		48 (45.7%)
Dominant side	Right		101 (96.2%)
	Left		4 (3.8%)
Revision surgery	Yes		6 (5.7%)
	No		99 (94.3%)

SD: Standard deviation, VAS: Visual Analog Scale, PedsQL: Pediatric Quality of Life Inventory, CSQ-8: Client Satisfaction Questionnaire-8

Table 2. Clinical and functional outcomes based on Gartland classification and reduction type

	Gartland classification			Reduction type		
	Type 2	Type 3		Open	Close	
	Mean±SD	Mean±SD	p*	Mean±SD	Mean±SD	p*
Age	10.06±1.8	10.2±2.1	0.6	9.8±1.7	10.2±1.9	0.43
Baumann angle	73.6±4.9	72.1±6.1	0.19	72.1±6.6	73.1±5.5	0.55
Capitellohumeral angle	44.8±5.08	44.9±6.7	0.9	45.9±6.7	44.6±5.8	0.42
Healing time (weeks)	3.6±0.5	3.8±0.6	0.05	4±0.7	3.7±0.5	0.04
Follow-up duration (months)	34.5±9	34.9±8.6	0.8	34±9.5	34.8±8.6	0.7
VAS score	0.2±0.5	0.3±0.7	0.4	0.18±0.5	0.3±0.6	0.46
PedsQL score	95.3±8.1	93.8±8.4	0.3	92.4±9.1	94.9±8.1	0.26
CSQ-8 score	26.7±4.7	26.2±4.6	0.6	25.2±5.7	26.7±4.3	0.23

*Independent sample t-test, SD: Standard deviation, VAS: Visual Analog Scale, PedsQL: Pediatric Quality of Life Inventory, CSQ-8: Client Satisfaction Questionnaire-8

Table 3. Comparison of Flynn cosmetic and functional outcomes

		Flynn cosmetic				p*	Flynn functional			p*
		1	2	3	4		1	2	3	
Gartland classification	2	22	25	1	2	0.11	28	21	1	0.36
	3	19	27	8	1		19	30	6	
Surgical approach	Open	9	5	3	0	0.15	7	8	2	0.65
	Close	32	47	6	3		40	43	5	
Gender	Female	9	11	3	1	0.83	10	12	2	0.9
	Male	32	41	6	2		37	39	5	

*Chi-square test

DISCUSSION

The most significant findings of this study are that Gartland type 2 fractures and cases treated with closed reduction exhibited shorter recovery times and higher PedsQL scores. Furthermore, patient and parent satisfaction, as measured by CSQ-8 scores, was significantly influenced by the presence of fracture-related injuries and the need for revision surgery.

In our study, Gartland type 2 fractures exhibited shorter recovery times compared to type 3 fractures. This finding is consistent with previous studies reporting similar recovery durations for less severe fractures (2,10,11). Additionally, our study indicates that closed reduction results in shorter recovery times compared to open reduction, thereby corroborating previous studies suggesting that closed techniques reduce complication rates and accelerate recovery (4,12,13). Prior studies have also recommended closed reduction whenever possible, as it minimizes surgical trauma and postoperative complications (13,14).

Although PedsQL scores in our study were higher in type 2 fractures and in cases treated with closed reduction, the differences were not statistically significant. This finding aligns with another study in the literature that did not observe a significant difference in long-term satisfaction between different treatment methods for SCH fractures (10). Another possible explanation for the lack of statistical significance is the overall high level of recovery observed across all groups. This suggests that despite the observed differences, appropriate surgical treatment of SCH fractures remains highly effective across different fracture types.

Parental expectations play a crucial role in managing a child's recovery, as they significantly influence their perception of the outcome and, consequently, their level of satisfaction (7,10,15,16). In our study, we observed that parental satisfaction, as measured by CSQ-8 scores, was negatively affected in patients with associated injuries and those requiring revision surgery. Notably, in the moderate CSQ-8 satisfaction group, the need for revision surgery was more prevalent. Previous studies have highlighted the impact of surgical complications and secondary interventions on satisfaction, reporting a direct correlation between surgical complications and parental dissatisfaction (6,15,16). Patients who sustained additional injuries during the initial

trauma were more likely to report lower satisfaction, likely due to prolonged treatment durations and increased postoperative challenges. These findings underscore the importance of comprehensive preoperative counseling and expectation management for patients and their families, particularly in cases involving complex fractures or potential complications.

In terms of functional and cosmetic outcomes, the Flynn criteria used in our study did not reveal significant differences between groups. This finding is consistent with the results of Rapp et al. (6), who reported that fracture type and surgical approach do not substantially affect the cosmetic outcomes of pediatric clavicle fractures. Similarly, the lack of significant differences in Baumann and capitellohumeral angles, between treatment methods, aligns with previous research indicating that radiological outcomes do not always correlate with perceived functional recovery or satisfaction (17). Another study in the literature suggests that, despite varying treatment approaches for different fracture types, satisfactory cosmetic and functional outcomes can be achieved with the appropriate surgical technique (18). This underscores the importance of radiological outcomes while also highlighting their limitations in fully capturing patient and parental experiences, emphasizing the need for more comprehensive satisfaction assessments.

Our study also identified a significant association between revision surgeries and lower satisfaction scores. This finding is consistent with the study by Keppler et al. (5), which reported that patients requiring multiple surgical procedures generally express lower levels of satisfaction. This highlights the importance of achieving optimal surgical outcomes to minimize the need for additional procedures. Furthermore, the challenges associated with managing fractures with concomitant injuries can significantly impact patient satisfaction (14).

One of the strengths of this study is its integration of both objective clinical measurements and subjective patient-reported outcomes, providing a comprehensive assessment of treatment success. By evaluating both radiological parameters and patient satisfaction measures, we were able to identify key factors influencing postoperative recovery from multiple perspectives. Additionally, the inclusion of parental satisfaction as an outcome measure adds a new dimension to the evaluation of pediatric fracture management (7).

Study Limitations

This study's retrospective design and single-center nature may limit its generalizability. While follow-up periods were adequate for short- and mid-term assessments, longer-term evaluations could provide further insights into treatment durability. Additionally, satisfaction surveys are subjective and may be influenced by psychological and familial factors.

CONCLUSION

Surgical treatment of SCH fractures in children yields favorable outcomes, with shorter healing times in Gartland type 2 fractures and when using closed reductions. While functional and cosmetic results remain similar across treatment groups, patient and parental satisfaction is influenced by concomitant injuries and the need for revision surgery.

ETHICS

Ethics Committee Approval: Ethical approval for the study was obtained from the Clinical Research Ethics Committee of the University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital (approval no: 2021-04-12, date: 15.02.2021).

Informed Consent: Informed consent was obtained from all individual participants and their legal guardians.

FOOTNOTES

Authorship Contributions

Surgical and Medical Practices: V.Ö., B.B.Ç., N.K.Y., M.Ç., A.B., A.D., Concept: V.Ö., A.B., A.D., Design: V.Ö., A.B., A.D., Data Collection or Processing: B.B.Ç., N.K.Y., M.Ç., Analysis or Interpretation: N.K.Y., A.B., A.D., Literature Search: N.K.Y., M.Ç., Writing: V.Ö.

Conflict of Interest: No conflict of interest was declared by the authors.

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