

EPIDEMIOLOGY AND TIME-RELATED PATTERNS OF PEDIATRIC SUPRACONDYLAR HUMERUS FRACTURES REQUIRING SURGERY

Çocuklarda Cerrahi Tedavi Edilen Suprakondiler Humerus Kırıklarının Epidemiyolojik ve Zamansal Özellikleri

Fatih BARÇA¹ Kadir ÇEVİK²

¹ Clinic of Orthopaedics and Traumatology, Ankara Etlik City Hospital, ANKARA, TÜRKİYE

² Clinic of Orthopaedics and Traumatology, Başakşehir Çam and Sakura City Hospital, İSTANBUL, TÜRKİYE

ABSTRACT

Objective: Supracondylar humerus fractures are common injuries in childhood and often require surgery. Our aim is to determine whether there is a relationship between supracondylar humerus fractures and their subtypes and temporal characteristics (seasonal/monthly/weekday-weekend/school time).

Material and Methods: In this single-center, retrospective clinical observational study, patients who presented to our hospital between January 2011 and December 2018 and underwent surgical treatment for pediatric supracondylar humerus fractures were examined. Demographic data, fracture type, the month and season in which the fracture occurred, whether fractures during the school term occurred during or outside of school hours, and weekday-weekend information were obtained from the records and analyzed.

Results: A total of 186 patients were included in the study (mean age 7.1±3.2, 67.2% male). Sixty-eight (36.6%) fractures occurred in the summer, 61 (32.8%) in the fall, 41 (22%) in the spring, and 16 (8.6%) in the winter. The highest number of patients presented in July, August, and September (25 patients each, 13.4%), while the lowest number presented in February (2 patients, 1.1%). One hundred twenty-five (67.2%) patients were admitted on weekdays and 61 (32.8%) on weekends. Of the patients who admitted on weekdays, 50 (40%) required open surgery, while 35 (57.4%) of those who were admitted on weekends required open surgery. The difference was found to be statistically significant ($p=0.026$). Seventy-four (50%) of school-aged children presented during the school term and twenty-two (29.7%) of these patients presented during school hours.

Conclusion: A majority of supracondylar humerus fractures requiring surgery occur during the summer and fall seasons. During the school term, most fractures occur outside school hours. Open surgery was required significantly more often for fractures that occurred on weekends than for those that occurred on weekdays.

Keywords: Elbow, surgical traumatology, humeral fractures

ÖZ

Amaç: Suprakondiler humerus kırıkları çocukluk çağında sık görülen ve sıklıkla cerrahi gerektiren yaralanmalardır. Amacımız suprakondiler humerus kırıkları ve bu kırıkların alt tipleri ile temporal özellikler (mevsimsel/aysal/hafta içi-sonu/okul zamanı) arasında herhangi bir ilişki olup olmadığını belirlemektir.

Gereç ve Yöntemler: Tek merkezli, retrospektif klinik gözlemsel çalışmada Ocak 2011- Aralık 2018 arasında hastanemizde başvuran ve cerrahi tedavi edilmiş pediatrik suprakondiler humerus kırığı olan hastalar incelendi. Demografik veriler, kırık tipi, hangi ayda ve hangi mevsimde gerçekleştiği, okul dönemindeki kırıkların okul saatinde veya dışında başvurduğu ve hafta içi-hafta sonu bilgisi kayıtlardan elde edildi ve analiz edildi.

Bulgular: Çalışmaya toplam 186 hasta dahil edildi (ort. yaş 7,11±3,2, %67,2 erkek). Kırıkların 68'i (%36,6) yaz mevsiminde, 61'i (%32,8) sonbahar mevsiminde, 41'i (%22) ilkbahar mevsiminde, 16'sı (%8,6) ise kış mevsiminde başvurdu. En çok hastanın Temmuz, Ağustos ve Eylül aylarında (25'er hasta, %13,4), en az hastanın ise Şubat ayında (2 hasta, %1,1) başvurduğu gözlemlendi. Kırıkların 125'i (%67,2) hafta içi, 61'i ise (%32,8) hafta sonu başvurdu. Hafta içi başvuran hastaların 50'si (%40), hafta sonu başvuranların ise 35'i (%57,4) açık cerrahiye gereksinim duydu. Aradaki fark istatistiksel olarak anlamlı bulundu ($p=0.026$). Okul çağındaki çocukların 74'ü (%50) okulun açık olduğu dönemlerinde başvurdu. Bu hastaların 22'si (%29,7) okulun açık olduğu saatlerde başvurdu.

Sonuç: Cerrahi gerektiren suprakondiler humerus kırıklarının önemli bir kısmı yaz ve sonbahar mevsimlerinde başvurmaktadır. Okulların açık olduğu dönemde kırıkların çoğunluğu okulların kapalı olduğu saatlerde başvurmuştur. Haftasonu başvuran kırıklarda açık cerrahi gereksinimi hafta içi başvuranlara göre anlamlı olarak daha fazla olmuştur.

Anahtar Kelimeler: Dirsek, cerrahi travmatoloji, humerus kırıkları



Correspondence / Yazışma Adresi:

Clinic of Orthopaedics and Traumatology, Ankara Etlik City Hospital, ANKARA, TÜRKİYE

Phone / Tel: +905452142889

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Dr. Fatih BARÇA

E-mail / E-posta: fatihbarca@hotmail.com

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INTRODUCTION

Supracondylar humerus fractures account for 15-18% of childhood fractures and 60-80% of elbow fractures, and they usually require surgical treatment.^{1,2} The incidence of supracondylar humerus fractures was reported to be 308/100 000 per year.³

In addition to its high incidence, determining the correct treatment approach and timing is also very important. It has been reported that up to 38% of these fractures are accompanied by circulatory disorders and up to 50% by neurovascular damage, requiring urgent surgical treatment.^{1,4,5} Besides, considering that 20% of the longitudinal growth of the humerus originates from the distal humerus physis, long-term complications can be catastrophic.¹ Early surgical complications develop in 13.7% of patients after supracondylar fractures, and long-term complications such as deformities, neurological deficits, and joint motion restriction may occur, with delayed treatment increasing the incidence of these complications.^{1,6}

For these fractures, Gartland classification is helpful in determining the treatment algorithm based on the type and amount of displacement.⁷⁻⁹ Surgical treatment is recommended for patients with Gartland type 2, 3, and 4 injuries, flexion-type injuries, and medial column collapse, as well as those with pulselessness, nerve deficits, excessive swelling, and the brachialis sign.^{1,2} Orthopedic consultation is often required when this patient group is encountered in emergency departments. It is important that the orthopedic team and healthcare system are prepared and equipped to manage these fractures. At this point, it is beneficial to know the epidemiological characteristics of these fractures so that surgical treatment, especially appropriate surgery, can be planned in a timely manner by the appropriate teams. Examining the seasonal/monthly distribution, whether schools are open or closed, and the relationship between fracture types and these characteristics will enable the provision of sufficient resources for treatment (i.e., pediatric trauma personnel, specialized orthopedic/trauma operating rooms, etc.). Although various studies have examined this topic, no consensus has been reached.^{3,10,11}

The aim of our study is to determine whether there is a relationship between surgical-requiring pediatric supracondylar humerus fractures and their subtypes and temporal characteristics (seasonal/monthly/weekday-weekend/school time).

MATERIALS AND METHODS

Our single-center, retrospective clinical observational study was conducted after obtaining ethical approval No. 50/04 from Ankara Dışkapı Yıldırım Beyazıt Training and Research Hospital Clinical Researches Ethics Committee, and the patients' data in the hospital

system were reviewed. Informed consent was waived due to the retrospective nature of the study, and the study was conducted in accordance with the Declaration of Helsinki.

Patients with supracondylar fractures who were followed up in the Orthopedics and Traumatology department of our hospital between January 2011 and December 2018 by a single orthopaedic team were retrospectively reviewed from the hospital information system. The inclusion criteria for the study were patients under the age of 18 who underwent surgical treatment on the same day due to isolated supracondylar humerus fractures (including lateral and medial condyle fractures). Patients who underwent surgical treatment due to additional injuries to the supracondylar humerus fracture, patients who could not be operated on the same day as the fracture, patients transferred from another center, patients with insufficient records, or patients whose admission X-rays were not suitable for fracture classification were excluded from the study. The study flowchart was shown in Figure 1.

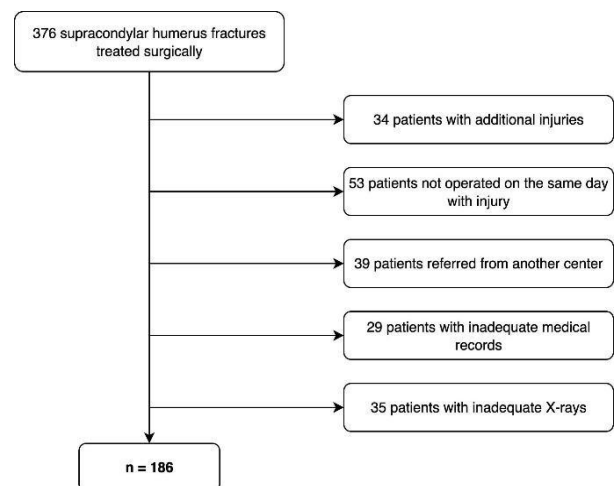


Figure 1: Study flowchart demonstrates that 186 patients were eligible after exclusion.

Patients referred from the emergency department were evaluated for neurovascular findings, and insufficient reduction on the cast X-rays or patients with neurovascular problems were prepared for surgical treatment. All surgeries were planned for the same day. In surgery, the quality of reduction was checked with fluoroscopy. If the reduction was adequate, percutaneous fracture fixation was performed. If closed reduction could not be achieved, open reduction was performed using an anterior, medial, or lateral approach, and fixation was achieved with Kirschner wires. Patients were discharged the day after surgery if postoperative problems were not observed. If no further problems were encountered after X-ray follow-ups, Kirschner wires and splints were removed in the first postoperative month.

The demographic data (age, sex), laterality, dominant hand information (if applicable), date of presentation (month, season, weekday or weekend presentation), and if during the school term (i.e. September to June), whether the presentation was during (8:30-17:00) or outside (17:00-08.30) school hours were obtained from hospital records for all patients. The patients' initial presentation radiographs were evaluated by two authors and the fractures were classified using the Gartland classification.⁷⁻⁹ Flexion-type fractures, medial and lateral condyle fractures were also classified separately. Information on whether the surgeries were performed using open or closed techniques was obtained from the surgical records.

Statistical analysis was performed using SPSS 26. The normality of numerical data was assessed using the Kolmogorov-Smirnov test. Since the data followed a normal distribution, parametric tests were applied. Descriptive and outcome data were reported as mean and standard deviation and frequency and percentage for categorical data. Differences between numerical values were analyzed using independent samples t test and categorical values were analyzed using chi-square test. p values less than 0.05 were considered significant.

RESULTS

A total of 186 patients were included in the study (mean age 7.1 ± 3.2 , 67.2% male). 59.7% of fractures were in the left elbow. Of the 148 patients with dominant hand information, 91 (61.5%) had fractures on the non-dominant side. The most common fracture type was Gartland type 2 fractures (88 patients, 47.3%). Descriptive data are shown in Table 1.

Table 1: Demographic and descriptive data

Age	7.1±3.2
Sex (Male) N (%)	125 (67.2)
Side (Right) N (%)	75 (40.3)
School age N (%)	148 (79.6)
Fracture of dominant side (n=148) N (%)	57 (38.5)
Fracture type N (%)	
Gartland type II	88 (47.3)
Gartland type III	55 (29.6)
Gartland type IV	4 (2.2)
Flexion type	3 (1.6)
Medial condyle/epicondyle	10 (5.4)
Lateral condyle/epicondyle	26 (14)
Surgery N (%)	
Closed	101 (54.3)
Open	85 (45.7)
Season N (%)	
Spring	41 (22)
Summer	68 (36.6)
Autumn	61 (32.8)
Winter	16 (8.6)
Weekends N (%)	61 (32.8)
In school hours (if schools were open) N (%)	22 (29.7)

Sixty-eight fractures (36.6%) occurred in summer, 61 (32.8%) in autumn, 41 (22%) in spring, and 16 (8.6%) in winter. No significant differences were found between fractures occurring in different seasons in terms of fracture type ($p=0.743$) or open or closed surgery requirement ($p=0.367$). The highest number of patients applied in July, August, and September (25 patients each, 13.4%), while the lowest number applied in February (2 patients, 1.1%) (Figure 2).

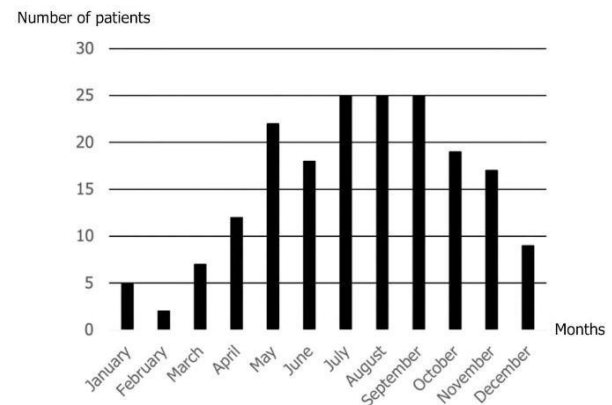


Figure 2: Bar graph demonstrates monthly distribution of surgically treated supracondylar humerus fractures.

One hundred twenty five fractures (67.2%) were reported during weekdays, while 61 (32.8%) were reported during weekends. No statistically significant difference was found in fracture type between patients who presented during weekdays and weekends ($p=0.942$). Fifty (40%) of the patients who presented during weekdays and 35 (57.4%) of those who presented on weekends required open surgery. The difference was statistically significant ($p=0.026$).

Seventy-four (50%) of school-aged children presented within school term of the year. Twenty-two (29.7%) of these patients presented during school hours. No difference was found between patients who presented during or outside school hours in terms of fracture type ($p=0.414$) and need for open surgery ($p=0.357$).

DISCUSSION

Supracondylar humerus fractures are frequently encountered in the emergency department; however, studies in the literature regarding the temporal distribution of these fractures are limited. In our study, we found that approximately 70% of supracondylar humerus fractures requiring surgery occurred during the summer and autumn seasons and were more frequent during non-school hours (school holidays and after-school hours). We also found that open surgery was required more often for fractures presenting on weekends.

The distal humerus is anatomically roughly triangular in shape and consists of the lateral epicondyle, capitellum,

trochlea, and medial epicondyle.¹ In the axial plane, it forms an hourglass shape due to the thin plate of bone located in the middle, in the olecranon fossa and coronoid fossa region.¹ Most fractures occur due to hyperextension of the elbow after falling on an open hand.^{1,5} Fracture occurs at the thinnest part of the bone, the anterior cortex and periosteum are torn, while the posterior cortex and periosteum may remain intact.¹ This is the mechanism of injury for extension-type fractures, which account for up to 95% of supracondylar fractures. Flexion-type fractures occur with a fall onto a flexed elbow and are much less common.^{1,12}

The most commonly used classification for supracondylar fractures is the Gartland classification.⁷ Injuries are defined as extension or flexion types based on the direction of displacement of the distal fragment. Extension injuries are initially classified as non-displaced (type I), minimally displaced (type II), and displaced (type III).⁷ Wilkins subsequently defined type IIA and type IIB subgroups based on the presence of rotational deformity.^{13,14} Leitch defined a new type, type IV, to indicate multiplanar instability with complete periosteal tear.⁸ The typical feature of Gartland type I supracondylar fractures is that they do not require reduction and are stable injuries regardless of the reduction method used.^{14,15} Gartland type II supracondylar fractures are controversial fractures in terms of surgical requirements.¹⁶ As suggested in the literature, our approach in our study was to perform surgical treatment if acceptable reduction criteria were not met after the initial reduction maneuver.¹⁷ In our study, 47.3% of the patients who underwent surgical treatment had a Gartland type II supracondylar humerus fracture.

Surgical reduction of supracondylar humerus fractures involves fixation with Kirschner wires in the reduced position, and reduction can be performed either open or closed.¹⁸ Closed reduction is attempted first in almost all cases. If closed reduction cannot be achieved (due to obstruction by neurovascular structures or the periosteum, or excessive instability), open surgery is required.^{19,20} After reduction is achieved using an anterior, posterior, medial, or lateral approach, depending on the fracture and the surgeon's preference, fixation is achieved with an appropriate number (2-4) of Kirschner wires. Open reduction was required in 85 (45.7%) of the patients in our study.

With the warming weather, an increase in overall trauma rates is expected due to children spending more time in parks and gardens. Ozbay et al. noted in their study that the incidence of supracondylar fractures increases in spring and summer and stated that more protective measures should be taken during these periods.¹⁰ Cake et al. stated in their 2016 study that the incidence increased in May and April and was lowest in

February.²¹ In our study, the most frequent presentations were in July, August, and September, while the least frequent were in February.

Although schools in our country's education system are closed for only three months, half of the patients who underwent surgery for supracondylar fractures during school age coincided with the school vacation period. This situation shows us that children are monitored more closely when schools are open and that families need to be better informed when schools are closed.

During the school term, the incidence of surgical fractures is higher after school hours, and the need for open surgery for these fractures is statistically significantly higher at weekends, regardless of the type of fracture. This may be because children are more closely supervised at school and avoid dangerous activities. The need for open reduction, which can be implied as a higher-impact trauma, might also indicate that children are more prone to such dangerous activities outside school. Also, the mobility of people and vehicles is higher during weekends, which might contribute to the higher rates of open surgery on weekends, since motor vehicle collisions mostly yield higher-impact trauma. Several hours of delay, which is more possible on weekends, could make closed reduction harder. More detailed analyses that focus on these issues would elucidate the reason for this high rate of open reduction necessity.

The limitations of our study include its retrospective nature and the fact that patient data were obtained from only one center in a single city. Nevertheless, since this center is a major trauma center and the data is from patients operated on by a team managed by the same clinical director for 10 years, it can be considered that these data reflect the demographics of the relevant community from the point of view of continuity of treatment protocols. The inclusion of only patients who underwent surgery is another limitation. However, considering that the preparedness of the surgical team is of paramount importance in such situations, the rationale for examining this patient population becomes more understandable. Finally, the large number of patients excluded from the study is another limitation. However, considering the impact of other injuries and accompanying factors on the surgical decision-making mechanism, it was only possible to evaluate the relevant patient population in isolation in this manner. Future prospective and multi-center studies may provide more insight about temporal patterns of this injury.

In conclusion, a majority of supracondylar humerus fractures requiring surgery were seen during the summer and fall seasons. During the school term, the majority of fractures occurred when schools were closed, and among fractures presenting on weekends, the need for open surgery was significantly higher than among those

presenting on weekdays. Understanding the temporal epidemiology of these fractures is important for preventing potential issues in the treatment plan and may help optimize resource allocation.

Conflict of Interest: The authors have no conflicts of interest to declare.

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