

Comparison of nighttime and daytime operation on outcomes of supracondylar humeral fractures

A prospective observational study

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Abstract

Supracondylar humeral fractures are seen in children and treatment is usually closed reduction and percutaneous pinning (CRPP). This surgery can be performed at night, depending on its urgency. Fatigue and sleep deprivation can impact performance of doctors during night shifts. The purpose of this study is to investigate the association between night shifts postoperative morbidity and mortality of supracondylar fracture operations compared to daytime procedures.

This prospective observational study included 94 patients who were aged 5 to 12 years with ASA I to III who had supracondylar humeral fractures, underwent CRPP under general anesthesia. Patients were stratified by the time of surgery using time of induction of anesthesia as the starting time of the procedure, into 2 groups: day (07:30 AM–06:29 PM) and night (06:30 PM–07:29 AM). In total, 82 patients completed the study: 43 in Group Day and 39 in Group Night.

The operation duration in Group Night (114.66 ± 29.46 minutes) was significantly longer than in Group Day (84.32 ± 25.9 minutes) ($P = .0001$). Operation duration (OR: 0.007; $P = .0001$) and morbidities (OR: 0.417; $P = .035$) were independent risk factors in Group Night.

Children who had supracondylar humeral fractures, undergoing urgent CRPP surgery, in-hospital mortality was associated with the time of day at which the procedure was performed. Patient safety is critically important for pediatric traumatic patient population. Therefore, we suggested to increase the number of healthcare workers and improve the education and experience of young doctors during night shifts.

Abbreviations: ASA = American Society of Anesthesiologists, BMI SDS = Standardized Body Mass Index, CRPP = closed reduction and percutaneous pinning, STROBE = Strengthening the Reporting of Observational Studies in Epidemiology.

Keywords: daytime, nighttime, supracondylar humeral fractures

1. Introduction

Supracondylar fractures are one of the most common traumatic fractures seen in children and the treatment is usually closed reduction and percutaneous pinning (CRPP), with the urgency depending on whether the hand remains perfused or not. Neurovascular complications associated with this fracture make it an orthopedic emergency.^[1–3]

Sleep deprivation, which is common in healthcare workers, can affect patient safety. Night shifts are important part of medical training. Anesthesiologists and orthopedic surgeons are required to make complex decisions at all times of the day. But also fatigue and sleep deprivation can negatively impact surgical skills, psychomotor, and cognitive performance of both experienced and inexperienced

doctors.^[4–8] Previous studies have revealed that long work hours can result in adverse consequences of medical procedures.^[7,8] Rothschild et al^[9] analyzed the surgical and obstetrical procedures and found that surgeons who had <6 hours sleep opportunity had significantly higher rates of complications than those who had a longer sleep opportunity. nighttime surgery may also be affected by factors such as less experienced on call staff and decreased hospital resources.^[4–10]

The purpose of our study was to investigate the association between night shifts supracondylar fracture operations and postoperative complications compared to daytime procedures. Our hypothesis was that night shifts supracondylar fracture operations would result in an increased rate of complications and affect patient safety.

The authors have no funding and conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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2. Materials and Methods

This prospective, observational study has been approved by the IRB of the authors' affiliated institutions and was registered with ClinicalTrials.gov (NCT04694469). The study was conducted between July and December 2019 at the Orthopedics and Traumatology Clinic of a tertiary university hospital in Istanbul. We informed the patient's parents about the anesthesia procedures and their involvement in the publication of the present study and obtained their written informed consent. Patients with American Society of Anesthesiologists (ASA) physical status I to III, aged 5 to 12 years, and who had supracondylar humeral fractures, underwent CRPP under general anesthesia, were enrolled to the study. The following exclusion criteria were used: standardized body mass index (BMI SDS) > +2 SD, congenital musculoskeletal disorders, refusing the study protocol. The study is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.^[11]

Patients were stratified by the time of surgery using time of induction of anesthesia as the starting time of the procedure, into 2 groups: day (07:30 AM–06:29 PM) and night (06:30 PM–07:29

AM). The patient demographics (age, BMI SDS), ASA physical statuses and comorbidities were recorded.

In all daytime operations, surgery was performed or supervised by the senior orthopedic surgeon and anesthesia was conducted and supervised by at least one the anesthesiologists. In nighttime operations, surgery was performed or supervised by the most senior orthopedic surgeon of the night shift. Anesthesia was conducted by a team of anesthesiology residents having a different level experience under the direct or indirect supervision of a staff anesthesiologist available 24 hours at the hospital. These surgeries were urgent and performed within 8 hours of admission.

Routine noninvasive monitoring was established, including noninvasive blood pressure, heart rate, pulse oximetry, electrocardiography, and temperature monitoring. All children induced 50% nitrous oxide oxygen mixture with 8% sevoflurane via the face mask. The trachea was intubated after the administration of fentanyl (1 µg/kg) and rocuronium (0.6 mg/kg). Anesthesia was maintained with sevoflurane (1%–2%, 1 MAC), and oxygen/nitrous oxide (40%/60%) for the duration of procedure.

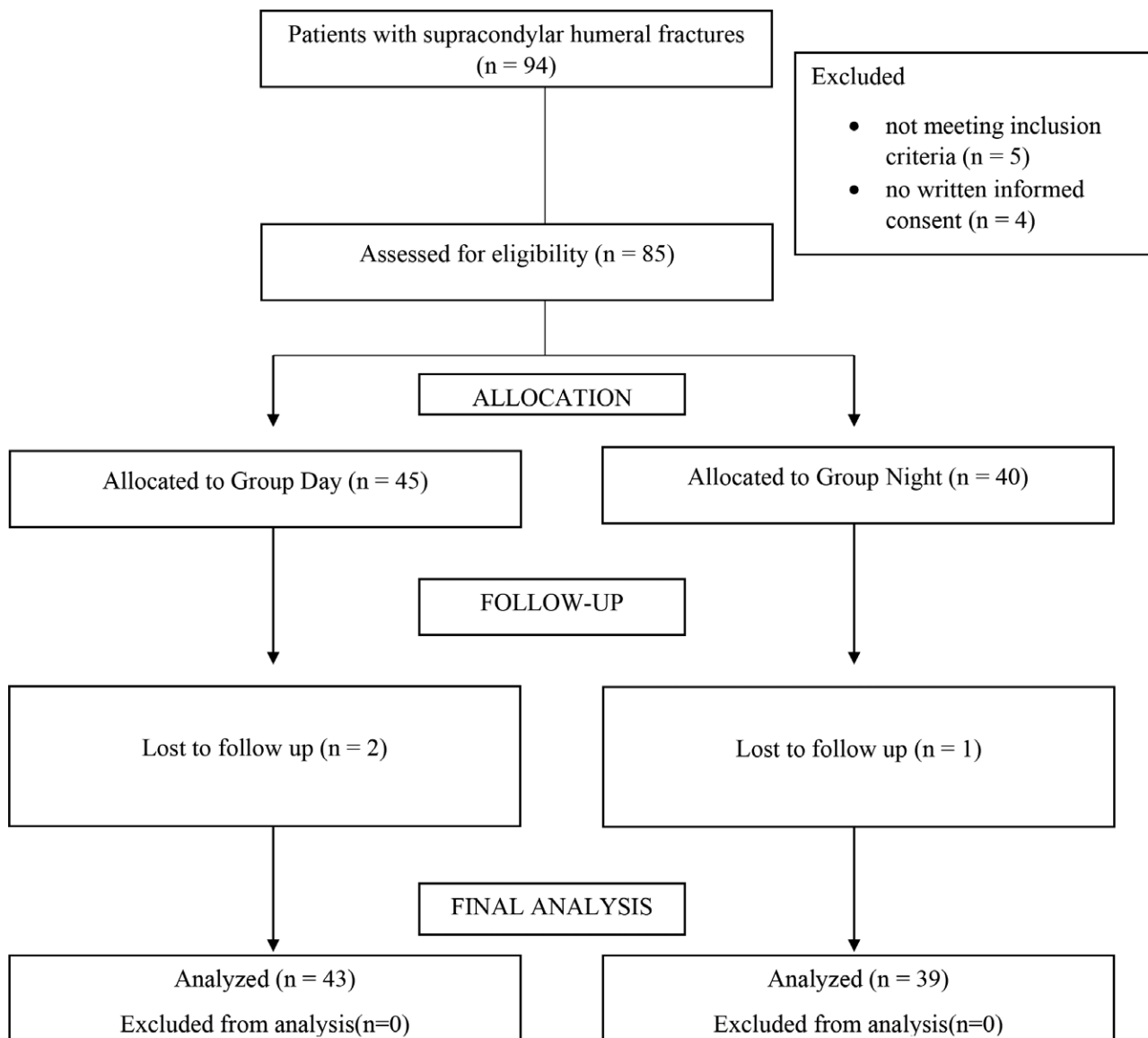


Figure 1. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) diagram of Groups Day and Night, who had supracondylar humeral fractures, underwent closed reduction and percutaneous pinning under general anesthesia.

The primary outcomes were 30-day morbidity defined as a composite outcome including neurovascular, bleeding, infection and pulmonary complications within 30 days of surgery. Secondary outcome was mortality within 30 days of surgery.

2.1. Statistical analysis

SPSS Statistics 2020 (IBM Corp. Released 2020, NY) software was used for statistical analyses. Descriptive statistical methods (mean, standard deviation, frequency, percentage,) were also used for the assessment of data. For the evaluation of parametric data, Student t test and Pearson Chi-square were used. To assess the nonparametric data, the Mann–Whitney U test was used. Linear logistic regression analysis was used to assess the correlation of the operation time and research parameters statistical significance was accepted as $P < .05$.

Sample Size Analysis was performed using the Power and Sample Size Program (P.S version 3.1.2). When we predict a 20% alteration for the duration of surgery prior data indicate that the difference in the response of matched pairs is normally distributed with standard deviation 1.7.^[12] If the true difference in the mean response of matched pairs is 0.79, we will need to study 38 pairs of subjects to be able to reject the null hypothesis that this response difference is zero with probability (power) 0.8. The Type I error probability associated with this test of this null hypothesis is 0.05. We needed at least 76 patients for the analysis and when possible dropouts are added, a total of 81 requirements are calculated.

3. Results

A total of 94 patients, who had supracondylar humeral fractures, underwent CRPP under general anesthesia, were eligible and enrolled to 1 of the 2 groups according to the time of surgery using time of induction of anesthesia as the starting time of the procedure, into 2 groups: day (07:30 AM–06:29 PM) and night (06:30 PM–07:29 AM). In total, 82 patients completed the study: 43 in Group Day and 39 in Group Night (Fig. 1).

There were no statistically significant differences in the mean age, BMI SDS measurements, comorbidities, and ASA scores of the patients between the groups ($P > .05$). The operation duration in Group Night (114.66 ± 29.46 minutes) was significantly longer than in Group Day (84.32 ± 25.9 minutes) ($P = .0001$) We found that the morbidity in Group Day was 2.3%, and the morbidity in Group Night was 15.4%. There were statistically significant differences in morbidity of the patients between the groups ($P = .036$) (Table 1). Postoperative complications included laryngospasm in 3 patients, bronchospasm in 1 patient

and surgical site wound infection in 3 patients. Two laryngospasm and 1 bronchospasm developed immediately after the early extubation period. One laryngospasm encountered in the recovery room 45 minutes after extubation. Laryngospasm and bronchospasm were treated medically and discharged to the ward for follow-up. Wound infections were detected in the postoperative 20, 35, and 60th day follow-ups of the patients. These patients underwent debridement and received antibiotic treatment.

The variables included in the study were evaluated by Linear regression analysis. According to the model, being operated at night had an effect on operation duration (OR: 0.007; $P = .0001$) and morbidity (OR: 0.417; $P = .035$) by increasing the risk. Operation duration and morbidities were independent risk factors (Table 2).

4. Discussion

In this prospective observational study, we found that nighttime shifts conduce to length of procedure and affect morbidity in hospital up to 30 postoperative days and pose a high risk.

The disruptive effects of shift working on the circadian rhythm manipulate the cognitive performance. Working night or early morning shifts impact on patient safety risk through clinical errors, many studies investigating the factors associated with increased morbidity and mortality.^[12–14]

At our institution, operating rooms serve after 06:30 PM with limited staffing. Night shift orthopedic surgical team consists of a surgeon, residents, and a nurse. Anesthesia team consist of a staff anesthesiologist with senior and junior residents. In our study, we found the durations of both anesthesia and surgery were longer in the nighttime. (Group Day: 84.32 ± 25.99 minutes vs Group Night: 114.66 ± 29.46 minutes, $P = .0001$) It can be conducted with decreased performance and alertness of the doctors. We believe that this result might be due to decreased hospital resources and difficulty to access the plant property equipment in nighttime operations. There are several papers reporting complications for surgeries performed during nighttime.^[12,13] Similarly, in a large cohort study, Cortegiani et al^[15] reported that intraoperative adverse events and postoperative pulmonary complications occurred more often in patients undergoing nighttime surgery. Perioperative respiratory complications are some of the most common critical events that can occur in pediatric patients.^[16] Sleep deprivation can therefore impair multitasking performance, negatively impact rational decision skills and prolonged reaction time.^[17] Identifying risk factors for complications and providing the best anesthetic care for children decreases perioperative respiratory adverse events.^[18] In

Table 1
Patient Demographics and Group Comparisons.

	Total patients, mean ± SD	Group day, n:43 (52.4%)	Group night, n:39 (47.6%)	P value
Age (y)	8.40 ± 3.83	8.93 ± 3.24	7.82 ± 4.37	.193
ASA				
1,00	74 (90.2%)	38 (88.4%)	36 (92.3%)	.519
2,00	7 (8.5%)	5 (11.6%)	2 (5.1%)	
3,00	1 (1.2%)	0 (0%)	1 (2.6%)	
BMI SDS	0.29 ± 0.84	0.24 ± 1.01	0.35 ± 0.68	.844
Comorbidity	14 (17.07%) (+) (-)	6 (14.0%) 37 (86.0%)	8 (20.5%) 31 (79.5%)	.430
Time of operation (min)	98.76 ± 31.46	84.32 ± 25.99	114.66 ± 29.46	.0001*
Morbidity				.036*
No	75 (91.5%)	42 (97.7%)	33 (84.6%)	
Yes	7 (8.5%)	1 (2.3%)	6 (15.4%)	

Data are presented as mean ± standard deviation (SD) (Student t test) and n (%) (Pearson Chi-square, χ^2).

ASA = American Society of Anesthesiologists, BMI SDS = standardized body mass index.

* $P < .05$ is defined as statistically significant.

Table 2
Linear regression analysis.

	OR	Sig.	95% CI for EXP (B)	
			Lower	Upper
Morbidity	0.417	0.035*	0.030	0.804
Operation time	0.007	0.0001*	0.004	0.010

**P* < .05 is defined as statistically significant.

this present study, laryngospasm occurred in 1 patient in day-time, however, laryngospasm in 2 patients, 1 bronchospasm and surgical site wound infection in 3 patients occurred in night-time surgery. (Morbidity in Group Day 2.3% vs Group Night 15.4%, *P* = .036.) All our patients in both groups had similar pre-existing comorbidities (Group Day: 14.0% vs Group Night: 20.5%, *P* = .430). Finally, we found the length of operations and morbidities were independent risk factors.

Previous studies evaluating the relationship between the time of day with postoperative morbidity and mortality provided different results.^[19-21] In a retrospective study Zafar et al,^[22] collected 49,827 adult trauma patients undergoing exploratory laparotomy, they found no significant difference in risk-adjusted mortality performed during out-of-hours compared with day-time. Chacko et al^[23] did not identify any differences of operated during after-hours versus daytime hours of hip fracture surgery in overall complication rates or overall mortality.

The limitation of this study is that it is based on data from a single center; therefore, further prospective studies with large number of patients are required.

5. Conclusion

Children who had supracondylar humeral fractures, undergoing urgent CRPP surgery, in-hospital mortality was associated with the time of day at which the procedure was performed. Patient safety is critically important for pediatric traumatic patient population. Therefore, we suggested to increase the number of healthcare workers and improve the education and experience of young doctors during night shifts.

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References

[1] Badkoobehi H, Choi PD, Bae DS, et al. Management of the pulseless pediatric supracondylar humeral fracture. *J Bone Joint Surg Am.* 2015;97:937-43.
 [2] Kumar V, Singh A. Fracture supracondylar humerus: a review. *J Clin Diagn Res.* 2016;10:RE01-6.

[3] Kropelnicki A, Ali AM, Popat R, et al. Paediatric supracondylar humerus fractures. *Br J Hosp Med (Lond).* 2019;80:312-6.
 [4] Parker RS, Parker P. The impact of sleep deprivation in military surgical teams: a systematic review. *J R Army Med Corps.* 2017;163:158-63.
 [5] Parry DA, Oeppen RS, Amin MSA, et al. Sleep: its importance and the effects of deprivation on surgeons and other healthcare professionals. *Br J Oral Maxillofac Surg.* 2018;56:663-6.
 [6] Tsafirir Z, Korianski J, Almog B, et al. Effects of fatigue on residents' performance in laparoscopy. *J Am Coll Surg.* 2015;221:564-70.e3.
 [7] Gates M, Wingert A, Featherstone R, et al. Impact of fatigue and insufficient sleep on physician and patient outcomes: a systematic review. *BMJ Open.* 2018;8:e021967.
 [8] Albergo JJ, Fernández MC, Zaifrani L, et al. How does sleep deprivation during 24 hours on call duty affect the cognitive performance orthopaedic residents? *Rev Esp Cir Ortop Traumatol.* 2016;60:113-8.
 [9] Rothschild JM, Keohane CA, Rogers S, et al. Risks of complications by attending physicians after performing nighttime procedures. *JAMA.* 2009;302:1565-72.
 [10] Wright MC, Phillips-Bute B, Mark JB, et al. Time of day effects on the incidence of anesthetic adverse events. *Qual Saf Health Care.* 2006;15:258-63.
 [11] von Elm E, Altman DG, Egger M, et al. STROBE Initiative. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *BMJ.* 2007;335:806-8.
 [12] Alnajashi SS, Alayed SA, Al-Nasher SM, et al. Will surgeries performed at night lead to worse outcomes? Findings from a trauma center in Riyadh. *Medicine (Baltim).* 2020;99:e20273.
 [13] Cortegiani A, Ippolito M, Misseri G, et al. Association between night/after-hours surgery and mortality: a systematic review and meta-analysis. *Br J Anaesth.* 2020;124:623-37.
 [14] Althoff FC, Wachtendorf LJ, Rostin P, et al. Effects of night surgery on postoperative mortality and morbidity: a multicentre cohort study. *BMJ Qual Saf.* 2020;bmjqs-2020-011684.
 [15] Cortegiani A, Gregoretti C, Neto AS, et al. LAS VEGAS Investigators, the PROVE Network, and the clinical trial network of the European Society of Anaesthesiology. Association between night-time surgery and occurrence of intraoperative adverse events and postoperative pulmonary complications. *Br J Anaesth.* 2019;122:361-9.
 [16] Egbuta C, Mason KP. Recognizing risks and optimizing perioperative care to reduce respiratory complications in the pediatric patient. *J Clin Med* 2020;9:1942.
 [17] Saadat H, Bissonnette B, Tumin D, et al. Effects of partial sleep deprivation on reaction time in anesthesiologists. *Paediatr Anaesth.* 2017;27:358-62.
 [18] Ramgolam A, Hall GL, Zhang G, et al. Inhalational versus intravenous induction of anesthesia in children with a high risk of perioperative respiratory adverse events: a randomized controlled trial. *Anesthesiology.* 2018;128:1065-74.
 [19] van Zaane B, van Klei WA, Buhre WF, et al. European Surgical Outcomes Study (EuSOS) Group for the trials groups of the European Society of Intensive Care Medicine and the European Society of anaesthesiology. Nonelective surgery at night and in-hospital mortality: prospective observational data from the European Surgical Outcomes Study. *Eur J Anaesthesiol.* 2015;32:477-85.
 [20] Tessler MJ, Charland L, Wang NN, et al. The association of time of emergency surgery- day, evening or night - with postoperative 30-day hospital mortality. *Anaesthesia.* 2018;73:1368-71.
 [21] Heller JA, Kothari R, Lin HM, et al. surgery start time does not impact outcome in elective cardiac surgery. *J Cardiothorac Vasc Anesth.* 2017;31:32-6.
 [22] Zafar SN, Libuit L, Hashmi ZG, et al. The sleepy surgeon: does night-time surgery for trauma affect mortality outcomes? *Am J Surg.* 2015;209:633-9.
 [23] Chacko AT, Ramirez MA, Ramappa AJ, et al. Does late night hip surgery affect outcome? *J Trauma.* 2011;71:447-53; discussion 453.