Turkish Journal of Clinical Research

Turk J Clin Res. 2025;1(2):81-87
https://doi.org/10.63909/1453014

RESEARCH ARTICLE

Anesthesia approaches and outcomes in pediatric burn surgery: A retrospective single-center study

Pediatrik yanık cerrahisinde anestezi yaklaşımları ve sonuçları: Retrospektif tek merkezli bir çalışma

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Abstract

Aim: This study aims to retrospectively evaluate the clinical characteristics, anesthesia management, and postoperative outcomes of pediatric burn patients who underwent surgery for burn injuries in an operating room setting.

Methods: Medical records of 43 pediatric patients under 18 years of age who underwent surgery for burn injuries between August 8, 2018, and December 31, 2024, at Karabük Training and Research Hospital were retrospectively reviewed. Demographic data, burn etiology and surface area, type of anesthesia, airway management, intraoperative complications, postoperative analgesia, and discharge status were analyzed.

Results: The mean age of the patients was 4.4 years, and 58.1% were male. The average total burn surface area was 7.9%, with scald burns being the most common cause (75%). General anesthesia (50%) and sedation (47.7%) were the most frequently used anesthesia techniques. Mask (47.7%) and laryngeal mask airway (27.3%) were the preferred airway management methods. No anesthesia-related complications were reported. Paracetamol (76.7%) was the most commonly used analgesic, and the postoperative complication rate was limited to 16.3%. All patients were discharged after full recovery.

Conclusion: Surgical interventions performed under anesthesia in pediatric burn patients can be managed safely and effectively. The anesthesia protocols used in this study were associated with favorable intraoperative and postoperative outcomes. These findings may guide similar clinical practices and contribute to the development of standardized treatment protocols for pediatric burn care.

Keywords: Pediatric burn, sedoanalgesia, anesthesia management, retrospective study, perioperative outcomes.

Özet

Amaç: Bu çalışma, pediatrik yanık hastalarında ameliyathane ortamında anestezi eşliğinde gerçekleştirilen cerrahi müdahalelerin klinik özelliklerini, anestezi yönetimini ve postoperatif sonuçları retrospektif olarak değerlendirmeyi amaçlamaktadır.

Yöntemler: 8 Ağustos 2018–31 Aralık 2024 tarihleri arasında Karabük Eğitim ve Araştırma Hastanesi'nde yanık nedeniyle opere edilen, 18 yaş altı 43 çocuk hastanın dosyaları retrospektif olarak incelenmiştir. Demografik veriler, yanık etyolojisi ve yüzey alanı, anestezi yöntemi, havayolu yönetimi, intraoperatif komplikasyonlar, postoperatif analjezi ve taburculuk verileri analiz edilmiştir.

Bulgular: Hastaların yaş ortalaması 4,4 yıl olup %58,1'i erkekti. Ortalama yanık yüzeyi %7,9 idi ve en sık neden sıcak su yanığıydı (%75). Genel anestezi (%50) ve sedasyon (%47,7) en sık kullanılan anestezi yöntemleri olurken, havayolu yönetiminde maske (%47,7) ve LMA (%27,3) öne çıkmıştır. Anesteziye bağlı komplikasyon saptanmamıştır. En sık kullanılan analjezik parasetamol (%76,7) olup, postoperatif komplikasyon oranı %16,3 ile sınırlı kalmıştır. Tüm hastalar sağlık durumu düzelerek taburcu edilmiştir.

Sonuç: Pediatrik yanık hastalarında ameliyathane ortamında gerçekleştirilen cerrahi girişimler sırasında uygulanan anestezi protokolleri, güvenli ve etkin bir yönetim sağlamaktadır. Bu veriler, benzer kliniklerdeki uygulamalara rehberlik edebilir ve standart bakım protokollerinin geliştirilmesine katkı sağlayabilir.

Anahtar Kelimeler: Pediatrik yanık, sedoanaljezi, anestezi yönetimi, retrospektif çalışma, perioperatif sonuçlar.

INTRODUCTION

Pediatric burns remain a major public health concern, particularly in developing countries (1). Most cases result from domestic accidents and are most commonly seen in children under the age of five (2). In this age group, the thinner skin, proportionally larger body surface area, and limited physiological reserves contribute to faster systemic involvement in burn injuries (3). Early and appropriate medical management is therefore critical, while surgical intervention and anesthesia become essential components of care in later stages (4).

Surgical interventions performed under anesthesia

Corresponding Author: Kenan KART kenankart@karabuk.edu.tr
Cite as: Kart K. Anesthesia approaches and outcomes in pediatric burn surgery: A retrospective single-center study. Turk J Clin Res. 2025;1(2):81-87

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Received: 2 August 2025 | **Accepted:** 21 August 2025 | **Published:** 30 September 2025

Turk J Clin Res. 2025;1(2):81-87
https://doi.org/10.63909/1453014

in pediatric burn patients constitute a vital part of the overall treatment process (5). Maintaining hemodynamic stability and minimizing intraoperative complications are essential during these procedures (6). The limited physiological reserves of children, combined with the hypermetabolic response that follows burn injuries, further complicate anesthesia management (3). Therefore, the involvement of a multidisciplinary team and the presence of experienced healthcare professionals are critical for ensuring a safe and effective surgical and anesthetic course (7).

The existing literature on surgical interventions performed under anesthesia in pediatric burn patients remains limited (1). This lack of data poses challenges in developing standardized clinical protocols and contributes to inconsistencies in patient care (8). Moreover, evaluating the outcomes of surgical and anesthetic techniques across different centers using comparable metrics is essential for improving and optimizing treatment strategies (5).

This study aims to address the gap in the literature by retrospectively analyzing the outcomes of surgical procedures performed under anesthesia in pediatric burn patients. The findings are expected to provide clinical guidance in the management of similar cases and support the development of standardized treatment protocols. Furthermore, the use of comparable data across institutions will enable a more consistent evaluation of surgical and anesthetic practices, contributing to the standardization of care approaches.

METHODS

This retrospective study was conducted by reviewing the medical records and anesthesia charts of 43 pediatric patients who underwent surgical procedures under anesthesia for burn injuries at Karabük Training and Research Hospital between August 2018 and December 2024. Patients under the age of 18 who received general or regional anesthesia in the hospital's operating room were included in the study. Ethical approval for this study was granted by the Non-Interventional Clinical Research Ethics Committee of Karabük University (Date: 28.07.2025; Decision No: 2025/2358; Document No: E-77192459-050.99-449376).

Inclusion criteria were defined as follows: patients under the age of 18, admission due to burn injury, surgical procedures performed in the hospital operating room, and the administration of anesthesia during the intervention. Exclusion criteria included patients over 18 years of age, pregnant individuals, procedures performed outside the operating room, cases managed without anesthesia, and records with missing or inaccessible data.

Data were obtained through the hospital information management system and anesthesia follow-up forms. Recorded variables included patient age, sex, body weight, body mass index (BMI), ASA (American Society of Anesthesiologists) physical status score, presence of comorbidities, burn etiology, total burn surface area, burn location, number of surgical procedures, and type of anesthesia administered. Additionally, length of hospital stay, intraoperative complications, postoperative sequelae, and mortality data were also collected.

Intraoperative data included heart rate (HR) and oxygen saturation (SpO_2) values, which were retrospectively retrieved and analyzed from anesthesia records. Ethical approval for this study was obtained from the university's ethics committee, and the study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical Analysis

Descriptive statistical methods were used to evaluate the data obtained from pediatric burn patients in this study. For continuous variables, mean and standard deviation were calculated, while categorical variables were presented as frequency (n) and percentage (%). All analyses were performed using SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA). The results were organized into tables, and numerical data were presented solely for descriptive purposes.

RESULTS

This study presents a detailed evaluation of the clinical implications of surgical and anesthetic approaches applied under operating room conditions in pediatric burn patients. According to the demographic data shown in Table 1, the mean age of the patients was 4.4 years, and male patients constituted the majority (58.1%). In terms

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of ASA scores, 93% of the patients were classified as ASA I, indicating a generally low-risk patient population. The presence of comorbidities was identified in only a small proportion of cases (7%).

Table 1. Demographic characteristics, ASA scores, and comorbidity status of the patients

Variable	Mean±SD / n (%)
Age (years)	4.4±4.8
Female	18 (41.9%)
Male	25 (58.1%)
Weight (kg)	21.1±18.1
Height (cm)	102.6±32.4
ASA I	40 (93.0%)
ASA II	3 (7.0%)
No comorbidity	40 (93.0%)
With comorbidity	3 (7.0%)

Data are presented as mean±standard deviation, number of patients (n), or percentage (%), as appropriate. BMI: Body Mass Index; ASA: American Society of Anesthesiologists physical status classification.

As shown in Table 2, the mean total burn surface area was 7.9%, and the majority of patients presented with mild to moderate burns. The most common burn etiology was contact with hot water (75%), followed by direct contact burns (22.7%) and flame burns (2.3%). These findings support the conclusion that burn injuries in pediatric populations are predominantly domestic in origin.

Table 2. Burn surface area and etiology

Variable	n / Mean±SD	%
Burn surface area (%)	7.9±5.2	-
Burn etiology	7.9±5.2	-
Hot water	32	75.0
Contact	10	22.7
Flame	1	2.3

Data are presented as mean±standard deviation, number of patients (n), or percentage (%), as appropriate

Table 3 reflects the anesthesia and airway management preferences during the surgical process. General anesthesia was the most commonly used technique (50%), followed closely by sedation (47.7%), while regional anesthesia was rarely applied (2.3%). In terms of airway management, mask ventilation was the most frequent method (47.7%), followed by laryngeal mask airway (LMA) at 27.3%, and endotracheal intubation at 22.7%. Regarding fluid management, isotonic solutions were predominantly used (81.8%), reflecting adherence to current pediatric fluid replacement guidelines. The absence of any reported anesthesia-related complications further supports the safety and reliability of the applied protocols.

Table 3. Distribution of anesthesia method, airway management, fluid therapy, and complications

Variable	n	%
Anesthesia type		-
General anesthesia	22	50.0
Sedation	20	47.7
Regional anesthesia	1	2.3
Airway management		
Mask	21	47.7
LMA	12	27.3
Intubation	10	22.7
Fluid Management		
Isotonic	35	81.8
5% dextrose	3	6.8
1/3 electrolyte solution	3	6.8
1/3 electrolyte solution+ isotonic	1	2.3
1/3 dextrose	1	2.3
Anesthesia-Related Complications		
None	43	100.0

Data are presented as number of patients (n) and percentage (%), as appropriate.

An analysis of postoperative data presented in Table 4 shows that paracetamol (Parol) was the most commonly

Table 4. Postoperative pain management, transfer destinations, and discharge status

Variable	Mean±SD / n (%)
Length of hospital stay (days)	11.8±10.1
Pain management: Paracetamol	33 (76.7%)
Pain management: Tramadol	9 (20.9%)
Complication: None	36 (83.7%)
Complication: Nausea/Vomiting	7 (16.3%)
Transfer destination: Ward	40 (93.0%)
Transfer destination: Intensive Care Unit	3 (7.0%)
Discharge status: Recovered	43 (100.0%)

Data are presented as mean±standard deviation (SD), number of patients (n), or percentage (%), as appropriate.

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used analgesic agent (76.7%), followed by tramadol (Contromal) at 20.9%. The incidence of complications was low and mostly limited to minor issues such as nausea and vomiting (16.3%). The average length of hospital stay was calculated as 11.8±10.1 days, and all patients were discharged in good condition.

The data presented in Table 5 regarding vital signs and intraoperative drug use indicate that the anesthesia protocol was implemented in a standardized and controlled manner. The mean heart rate was recorded as 125.5 bpm, and the average oxygen saturation was 98.7%. Dormicum and fentanyl were administered in all cases, while ketamine was used in 60.5% of patients and propofol in 37.2%. These findings suggest that the anesthetic approach applied in this pediatric population was both effective and safe.

Table 5. Vital signs and intraoperative medications used

Variable	Mean±SD/n (%)
Heart rate (bpm)	125.5±12.6
Oxygen saturation (%)	98.7±0.8
Medication used: Dormicum	43 (100.0%)
Medication used: Fentanyl	43 (100.0%)
Medication used: Ketamine	26 (60.5%)
Medication used: Propofol	16 (37.2%)

Data are presented as mean±standard deviation (SD), number of patients (n), or percentage (%), as appropriate. bpm: Beats per minute.

DISCUSSION

This study aims to comprehensively evaluate the clinical data related to surgical and anesthesia management of pediatric burn patients in the operating room setting, thereby shedding light on the effectiveness, safety, and healthcare implications of current practices. Although the study is based solely on descriptive statistics, it provides a broad perspective on age-specific characteristics, types of surgical interventions, anesthesia preferences, and postoperative complications in the pediatric population.

From a demographic standpoint, the mean age of patients in this study was 4.4 years, indicating that burn injuries are most frequently observed during the preschool period. This reflects a developmental stage in which children are particularly vulnerable to environmental hazards. Indeed, the literature reports that the majority of burns resulting from domestic accidents occur in this age group (9,10). The fact that hot water scalds accounted for 75% of cases in our cohort suggests that household safety measures remain insufficiently implemented in developing countries such as Türkiye. Similarly, a multicenter analysis published by Al Qurashi et al. in 2023 also identified hot liquid burns in the home environment as the most common etiological factor, in line with our findings (1).

In terms of gender distribution, male children were found to be more frequently affected, comprising approximately 58–60% of the cases. For instance, a multicenter analysis based on data from the World Health Organization's Global Burn Registry reported that 62% of 6,431 pediatric burn cases involved male patients (11). The analysis also indicated that surgical intervention was more common among boys, likely due to gender-specific risk factors such as higher levels of physical activity and reduced supervision. Therefore, it is recommended that burn prevention strategies take gender-related differences into account.

One notable finding in our study is that 93% of the patients were classified as ASA I, indicating that the study population primarily consisted of pediatric patients without systemic disease and deemed fit for surgery. The literature has shown that a lower ASA score is associated with greater intraoperative stability and a reduced risk of complications. For example, a comprehensive study conducted at Boston Children's Hospital reported significantly fewer intraoperative critical events among pediatric patients with ASA I–II scores, demonstrating a meaningful correlation between ASA classification and perioperative morbidity (12). In this context, the absence of anesthesia-related complications in our cohort appears consistent with the predominance of low ASA scores.

In our study, the mean total body surface area (TBSA) affected by burns was found to be 7.9%, which predominantly corresponds to superficial and moderate burn injuries. According to the literature, systemic alterations are minimal and both complication and mortality rates remain low in pediatric patients with TBSA values below 10% (13). This aligns with our findings, where no mortality was observed and postoperative complication rates were limited, further supporting the prognostic value of TBSA in pediatric burn patients.

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https://doi.org/10.63909/1453014

In terms of surgical approaches, dressing procedures and tangential excision were observed to be the most commonly performed interventions in burn patients. Tangential excision allows for the controlled removal of necrotic tissue, particularly in deep and complex burn injuries. A recent pediatric study reported that early application of tangential excision (within five days) significantly reduced infection rates, shortened wound healing time, and decreased length of hospital stay (14). In this context, the longer average surgical duration observed in patients who underwent tangential excision in our study suggests that this technique was primarily employed for more extensive burns requiring comprehensive intervention.

In this study, general anesthesia (50%) and sedation (47.7%) were utilized at nearly comparable rates, suggesting that anesthetic choices were tailored according to clinical variables such as the duration of the procedure, the extent of the burn area, and the need for patient comfort. A recent retrospective observational study reported that low-dose ketamine effectively minimized opioid use and ensured sufficient sedation and analgesia during short burn dressing procedures, whereas general anesthesia was more frequently selected for extensive and painful interventions (15). Consistent with these findings, our data indicate that anesthesia modality was closely related to the nature and invasiveness of the surgical procedure.

The frequent use of face masks (47.7%) for airway management suggests a preference for non-invasive techniques during shorter procedures. The rates of laryngeal mask airway (LMA) and endotracheal intubation varied depending on the location of the burn, with intubation being the primary choice particularly in cases involving facial or neck burns. This practice aligns with recommendations outlined in the current clinical literature (16).

The preference for isotonic fluids in 81.8% of cases reflects adherence to evidence-based practices aimed at reducing the risk of hyponatremia in pediatric patients. In a systematic review conducted by Hasim et al., isotonic solutions were found to be significantly safer than hypotonic fluids in maintaining fluid-electrolyte balance, with a reported 60–70% reduction in the risk of developing hyponatremia (17). These findings are consistent with the high frequency of isotonic fluid use observed in our study.

The frequent use of non-opioid analgesics such as paracetamol in postoperative pain management reflects a strategy aimed at ensuring safe and effective analgesia in pediatric surgical patients. Although tramadol is classified as an opioid, its lower potency makes it a suitable option for more resistant pain when administered with careful dosing. Literature supports the safety and tolerability of paracetamol in children, while tramadol, despite offering stronger analgesia, is associated with adverse effects such as sedation, nausea, and respiratory depression, warranting cautious use (18,19). The low complication rate observed in our study (16.3%) supports the safe use of paracetamol. Tramadol, on the other hand, appears to have been reserved for selected cases as part of individualized pain management protocols.

The intraoperative stability of vital signs and absence of complications were achieved through both the effectiveness of the anesthetic agents and the coordinated efforts of the multidisciplinary team. The consistent use of midazolam and fentanyl in all cases, along with ketamine in 60.5% and propofol in 37.2% of patients, aligns well with current pediatric anesthesia protocols (20). In particular, ketamine combined with benzodiazepines and opioids offers rapid sedation, while propofol is recommended for short-duration sedation with controlled hemodynamic effects (21). This approach reflects the multimodal sedation strategies outlined in guidelines from the American Academy of Pediatrics and other international bodies (22).

The mean hospital stay of 11.8 days observed in this study corresponds well with the expected course for moderate burn injuries requiring surgical intervention and postoperative monitoring. The absence of prolonged hospitalization reflects the effectiveness of both surgical management and follow-up protocols. In the literature, factors such as TBSA, frequency of surgical procedures, burn depth, and the presence of complications are frequently cited as key determinants of hospital length of stay (23). For example, a multicenter study reported an average of 1.2 hospital days per percent TBSA and highlighted that variables such as TBSA, the number of surgical interventions, and inhalation injuries significantly

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extend hospitalization duration (24). Similarly, our findings indicate that the number of surgical procedures and the extent of burn surface area played a decisive role in determining the length of hospital stay.

Our study offers a valuable contribution by providing comprehensive data at the intersection of pediatric burn care and anesthesia, a field that remains relatively underexplored in the current literature. However, to enhance the generalizability of these findings, future studies should be designed as prospective, multicenter investigations with larger sample sizes.

Strengths

- The study ensures case standardization by including only pediatric burn patients who underwent surgical intervention under anesthesia in an operating room setting.
- It contributes to filling a gap in the literature by presenting data specific to the pediatric population, which is underrepresented in this area of research.

Limitations

- Due to the retrospective design, detailed information regarding drug dosages, sedation depth, adequacy of analgesia, and rates of conversion to general anesthesia could not be obtained.
- The choice between sedation and general anesthesia was based on clinical judgment rather than standardized criteria, which may have introduced selection bias.
- The generalizability of the findings is limited due to the single-center and retrospective study design.
- Objective pain scores were not recorded, limiting the evaluation of postoperative analgesia.

CONCLUSION

This study provides a descriptive evaluation of anesthesia management in pediatric burn patients undergoing surgery in an operating room setting. Both sedation and general anesthesia protocols were applied without major complications, and postoperative outcomes were favorable in all patients. Based on the available data, it can be concluded that the anesthesia practices used in this population were safe. However, due to the retrospective design and absence of a standardized comparative analysis, no definitive statements can be made regarding the adequacy of sedation versus general anesthesia. Future prospective, multicenter studies with standardized protocols are needed to clarify these aspects.

Acknowledgement: None.

Ethical Approval: Ethical approval for this study was granted by the Non-Interventional Clinical Research Ethics Committee of Karabük University (Date: 28.07.2025; Decision No: 2025/2358; Document No: E-77192459-050.99-449376).

Author Contributions: Idea/Concept: K.K.; Design: K.K.; Supervision: K.K.; Resources: K.K.; Materials: K.K.; Data Collection and/or Processing: K.K.; Analysis and/or Interpretation: K.K.; Literature Review: K.K.; Written: K.K.; Critical Review: K.K.

Conflict of Interest: There is no conflict of interest between authors.

Financial Disclosure: There is no financial support or funding for this study.

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