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Our anaesthesia experiences and methods in burn patients

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Abstract

The objective of this study was to retrospectively evaluate the anaesthesia experiences of burn patients admitted to the Ankara Bilkent City Hospital Burn Treatment Centre between 2019 and 2021. The study also aimed to identify the types of anaesthesia applied to these patients. After obtaining the approval of the Ethics Committee (E2-23-5042), the demographic data of the patients, percentage and degree of burn, aetiology of burn injury, number of surgical procedures performed and the types of anaesthesia administered, were evaluated through a retrospective review of the patient files. A total of 421 out of 462 inpatients underwent surgery under anaesthesia at least once. A total of 1,430 surgical procedures were conducted under anaesthesia in 421 patients. Sedoanalgesia was performed in 67.9% of cases, general anaesthesia in 29.8%, and regional anaesthesia in 2.3%. Anaesthetists bear a significant responsibility for the care of burn patients during surgical and intensive care procedures. It is imperative that anaesthetists are aware of the pharmacokinetic and pharmacodynamic changes that occur in burn patients, in order that they may determine the appropriate doses of the most suitable agents. In the context of multidisciplinary burn patient treatment, anaesthesiologists play a pivotal role in communication and collaboration with other members of the surgical and intensive care teams, thereby significantly impacting patient outcomes.

Keywords: Adult burn, anesthesia, operative management

Introduction

A burn injury is regarded as the most severe form of trauma a patient can experience. Burns represent a complex trauma and are a leading cause of morbidity and mortality. It has been reported that approximately 600,000 individuals in the United States of America are exposed to a burn injury requiring emergency care on an annual basis [1]. As reported by the World Health Organisation, 180,000 deaths worldwide are attributed to burn-related causes annually [2].

Burns are classified as major, moderate, or minor based on their depth, extent, and location. National and international burn treatment algorithms have determined the indications for hospitalisation of patients by considering these groups. Accordingly, approximately one-quarter of burn cases receive inpatient treatment. The majority of patients who require inpatient treatment require surgical intervention under anaesthesia. At our centre, which accepts patients from across the globe, surgical intervention is conducted under anaesthesia in two operating theatres located within the centre.

The objective of this study was to retrospectively evaluate the anaesthesia experiences of burn patients admitted to the Ankara Bilkent City Hospital Burn Treatment Centre over a two-year period between 2019 and 2021. Additionally, the study aimed to identify the types of anaesthesia applied to these patients.

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Material and Methods

After obtaining the approval of the Ethics Committee (E2-23-5042), a retrospective review of patient files from the Ankara Bilkent City Hospital Burn Treatment Centre was conducted for patients who received treatment as inpatients between 2019 and 2021. The patient files were consulted in order to record the demographic data, burn percentages and degrees, and burn etiologies. The number of surgical procedures performed during the course of inpatient treatment, along with the specific surgical techniques and anaesthetic methods employed, were subjected to detailed examination. Patients with a burn area exceeding 20% of the total body surface area (TBSA) were classified as having major burns. Patients with a burn area of 10-20% were considered to have moderate burns, while those with a burn area of less than 10% were classified as having minor burns.

Statistical Analysis

The data were subjected to statistical analysis using IBM SPSS Statistics version. The IBM SPSS Statistics software package (IBM Corporation, Armonk, NY, USA) was used for the statistical analysis. The clinical and demographic data were analysed using mean and standard deviation, while the comparison between groups was evaluated using the chi-square test. The results were considered statistically significant for $p<0.05$. The study was approved by the Ethics Committee of Ankara Bilkent City Hospital on 27/09/2023, with the approval number E2-23-5042.

Results

A total of 462 patients were treated as inpatients at the burn treatment centre between February 2019 and January 2021. A total of 421 inpatients underwent at least one surgical procedure under anaesthesia. The mean age of the patients who underwent surgery was 38.36±15.76 years, with 282 males and 139 females. Of the patients who underwent surgery, 174 (41.3%) sustained flame burns and 145 (34.4%) sustained burns from hot liquids. The percentage of burn TBSAs ranged from 1% to 100%, with a mean value of 14.8%. Of the patients who underwent surgery, 254 had sustained minor burns, 98 had suffered major burns, and 69 had experienced moderate burns (Table 1).

Table 1. Characteristics of the patients operated under anaesthesia

Total number of patients	421
Age	
Mean±SD	38.36±15.76
Median	34
Range	18-93
Gender	**N, %**
Male	282, 62%
Female	139, 33%
Burn etiology	**N, %**
Flame	174, 41.3%
Hotwater	145, 34.4%
Electricity	51, 12.1%
Chemical	34, 8.1%
Contact	15, 3.6%
Friction	2, 0.5%
Burn severity	**N, %**
Major	98, 23.3%
Moderate	69, 16.4%
Minor	254, 60.3%
Burned TBSA*	**%**
Mean±SD	14.28±16.65
Median	8
Range	1-100

* TBSA: total body surface area

A total of 1,430 surgical procedures were conducted under anaesthesia on 421 patients. The mean number of anaesthetics administered per patient was 6.2 for those with major burns, 4.34 for those with moderate burns and 2.05 for those with minor burns. The sedoanalgesia method was applied statistically significantly more frequently than other anaesthesia methods in all major, moderate and minor case groups (61.18%, 56.33% and 82.37%, respectively; p=0.000). Among the anaesthesia methods applied, sedoanalgesia was employed in 971 cases (67.9% of the total number of cases), while general anaesthesia was used in 426 cases (29.8% of the total number of cases). Regional anaesthesia was performed in 33 cases (2.3%) (Table 2).

Table 2. Types of anaesthesia and burn severity

	Major (%)	**Moderate (%)**	**Minor (%)**	**Total**	**p-value**
Number of patients	98 (23.3)	69 (16.4)	254 (60.3)	421	
Number of anaesthesia performed	608 (42.5)	300 (21)	522 (36.5)	1430	
Average number of anaesthesia per patient	6.2	4.34	2.05	3.39	
Anaesthesia type					0.000
General anaesthesia	221 (51.9)	121 (28.4)	84 (19.7)	426 (29.8%)	
Sedation	372 (38.3)	169 (17.4)	430 (44.3)	971 (67.9%)	
Spinal	15 (45.5)	10 (30.3)	8 (24.2)	33 (2.3%)	

A review of the surgical procedures performed revealed that escharectomy was conducted in 476 of the 1,430 anaesthetised cases, while negative pressure wound therapy (NPWT) was employed in 323 cases. Following these procedures, the most common subsequent interventions were partial-thickness graft application (289 times) and epidermis equivalent application (123 times) (Table 3).

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Table 3. Types of anaesthesia applied during surgical procedures

		Types of anaesthesia			Total
		General anaesthesia	Sedation	Spinal anesthesia	
Surgical procedure n (%)	**AMHAT application**	3 (10.0)	26 (86.7)	1 (3.3)	30
	Amputation	4 (57.1)	2 (28.6)	1 (14.3)	7
	Dermis skeleton application	13 (40.6)	18 (56.3)	1 (3.1)	32
	Escharectomy	92 (19.3)	381 (80.0)	3 (0.6)	476
	Excision-primary repair	5 (31.3)	11 (68.8)	0 (0.0)	16
	Fascial excision-dermis skeleton	13 (100.0)	0	0	13
	Fascial excision-graft	23 (88.5)	2 (7.7)	1 (3.8)	26
	Fasciatomy	4 (57.1)	3 (42.9)	0	7
	Flap application	7 (77.8)	1 (11.1)	1 (11.1)	9
	Dermis equivalent-graft	8 (80.0)	2 (20.0)	0	10
	Hydrosurgery	11 (52.4)	10 (47.6)	0	21
	NPWT application	18 (5.6)	300 (92.9)	5 (1.5)	323
	NPWT -graft	11 (30.6)	25 (69.4)	0	36
	Epidermis equivalent application	31 (25.2)	87 (70.7)	5 (4.1)	123
	Partial thickness skin grafting	180 (62.3)	94 (32.5)	15 (5.2)	289
	SVF, PRP	3 (25.0)	9 (75.0)	0	12
Total		426 (29.8)	971 (67.9)	33 (2.3)	1430

AMHAT: autologous minimally-manipulated homologous adipose tissue, NPWT: negative pressure wound therapy, SVF: stromal vascular fraction, PRP: platelet rich plasma

Discussion

Anaesthetists bear significant responsibilities in the management of burn patients, whether in the operating room or the intensive care unit. Anaesthetists involved in the treatment of burns provide support in a number of key areas, including airway management, haemodynamic support, intravascular access, thermoregulation, pain and anxiety management, pulmonary support, resuscitation and anaesthesia in the intensive care unit. They also provide anaesthesia during burn eschar debridement, grafting and other surgical interventions.

The management of burn patients presents a number of challenges, particularly in relation to intraoperative fluid resuscitation, the selection of appropriate anaesthetic agents and their doses, and the determination of optimal ventilation strategies. These challenges are a result of the complex pathophysiological changes that are specific to burn patients. The anaesthesiologist is pivotal in optimising the care of these patients [3-5].

In patients with burns, a range of anaesthetic techniques may be employed, including deep sedoanalgesia, general anaesthesia in cases of extensive burns, ARDS, and regional anaesthesia in selected cases. In accordance with the patient's overall condition, whether or not the patient is in burn shock, and the extent of the burn, the anaesthesia method is determined through collaboration with the surgical and anaesthesia teams, with due consideration for the patient's interests. The anaesthetic management of the burned patient can be quite complex due to the presence of various pathophysiological and haemodynamic changes, particularly in instances where the burn involves more than 20% of the total body surface area.

The selection of anaesthetic agent for use in burn patients is contingent upon the haemodynamic and pulmonary status of the patient, in addition to the potential challenges associated with securing the airway. One of the most frequently utilised anaesthetic agents in the context of burns is ketamine. Ketamine, an N-methyl-D-aspartate (NMDA) antagonist with anaesthetic, amnesic and analgesic properties, is employed as the primary anaesthetic agent by some centres due to its numerous potential advantages for anaesthetic induction and maintenance in burn patients [6]. The effect starts quickly (on average 30-40 s) and lasts for a short period (5-10 min) [7]. The administration of ketamine has been demonstrated to protect hypoxic and hypercapnic responses by providing haemodynamic stability in patients without underlying respiratory compromise. Furthermore, it has been shown to decrease airway resistance with a bronchodilator effect and to protect airway reflexes. Due to these characteristics, it offers a distinct advantage, particularly in the context of burn cases [3,7,8]. It is important to note that the use of this medication may potentially increase the risk of laryngospasm due to the induction of hypersalivation. To reduce the likelihood of psychomimetic adverse effects, such as hallucinations, it is typically advised to administer ketamine in conjunction with benzodiazepines or propofol infusion. Furthermore, ketamine has been demonstrated to possess anti-inflammatory properties in patients with burns and sepsis [3].

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The pharmacological action of ketamine is to stimulate the central sympathetic system and the cardiovascular system directly. The reuptake of catecholamines is inhibited, resulting in an increase in their circulating levels. Consequently, this results in the development of hypertension and tachycardia [9]. Nevertheless, bolus ketamine doses may precipitate hypotension, particularly in instances of extensive burns, due to the continuous elevation of catecholamine levels, which results in desensitisation and downregulation of β-adrenoreceptors [3]. However, its judicious use in conjunction with other anaesthetic agents represents a favourable option for haemodynamically unstable patients. While anaesthetics typically induce hypotension, ketamine remains a viable option for anaesthetic management of burn patients experiencing haemorrhage and haemorrhagic shock. Furthermore, it offers a distinct advantage in the context of burn patients, as it does not affect renal blood flow and does not induce renal damage.

Nevertheless, evidence indicates a potential correlation between the administration of ketamine for sedation or analgesia and the development of cholestasis in critically ill major burn patients [10]. Although a reduction in cholestatic liver damage and lower 3-month mortality were observed with ketamine restriction, it has been reported that there may be numerous causes of cholestasis in patients with severe burns, and it cannot be definitively stated that this is directly related to ketamine [11].

In this retrospective study, sedoanalgesia was performed in the majority of patients. In our anaesthetic procedures, sedoanalgesia was performed with intravenous ketamine and low doses of propofol and midazolam in patients who were not scheduled to undergo major surgery. It is our contention that this approach offers protection to the patient from the risks associated with invasive anaesthesia procedures and immunosuppression, which may result from repeated anaesthesia procedures. In the context of facial burns, particularly those caused by inhalation, maintaining airway patency may prove challenging, and the risk of difficult intubation cannot be discounted. The administration of ketamine for sedation purposes, without compromising the airway or necessitating intubation, serves to mitigate this risk. Furthermore, we hypothesise that sedation may protect the patient from intubation and hospital-associated pneumonia.

In cases of general anaesthesia, the induction of anaesthesia may be performed intravenously or by inhalation. In the maintenance of anaesthesia, inhalation agents may be combined with nitrous oxide or intravenous agents. The use of volatile agents in burn patients is not associated with any notable differences [3]. It is important to note that the pharmacology of muscle relaxants is significantly affected in burn patients who will undergo general anaesthesia. It is advisable to avoid the use of depolarising muscle relaxants such as succinylcholine, as they have the potential to cause hyperkalaemia, which could prove fatal due to the upregulation of non-junctional nicotinic acetylcholine receptors 24 hours after the injury has occurred [12]. A reduction in sensitivity to the neuromuscular effects of non-depolarising muscle relaxants has been observed, with higher doses than normal being required. The reason for resistance to non-depolarising muscle relaxants is both pharmacodynamic and pharmacokinetic in nature [3].

It is common practice for burn patients to receive anaesthesia for repetitive surgical procedures. It has been documented that neurocognitive toxicity associated with general anaesthesia may manifest and that repeated exposure to low doses of anaesthetic agents may contribute to this phenomenon [13]. It has been demonstrated that general anaesthesia stimulates physiological autophagy and provides cytoprotection. However, excessive use of anaesthesia has been shown to impair autophagy function, which in turn has been linked to an increased risk of neuronal damage and cell death [14]. A rational strategy for the safe use of general anaesthesia is to avoid its overuse, whether in excessive concentration or duration. Furthermore, the avoidance of inhalation agents, which have been implicated during repeated anaesthesia applications, may also prove beneficial in preserving neurocognitive status. It can therefore be posited that sedoanalgesia is advantageous in the treatment of burn patients.

In the search for prophylaxis and treatment against postoperative cognitive dysfunction, anaesthetic adjuvant dexmedetomidine is emerging as a promising candidate. Dexmedetomidine, an α-2 adrenergic receptor agonist, has been demonstrated to exhibit analgesic, sedative, anxiolytic and sympathomimetic effects without the adverse effect of respiratory depression [15]. It is postulated that the agent in question interacts with a number of different physiological and biochemical pathways within the central nervous system. Dexmedetomidine exerts its inhibitory effect on neuronal activity by binding to the α-2 adrenoceptor in the locus ceruleus. This results in the release of the inhibitory neurotransmitters, namely GABA and galanin into the cortex, thereby promoting natural sleep-like sedation. [16,17]. However, it is not sufficient alone for painful burn surgeries. Since it may cause hypotension at high doses and in the presence of hypovolemia, it should not be used in haemodynamically unstable patients.

Regional anaesthesia is employed in selected cases in the context of burn patient care. In the course of our study, regional anaesthesia was employed in 2.3% of the cases that were received over a three-year period. Regional anaesthesia confers advantages through the provision of intraoperative anaesthesia, the enhancement of postoperative analgesia and the facilitation of rehabilitation. Regional anaesthesia may be administered in a variety of forms, including local anaesthetic injections into the donor site, subcutaneous catheter application, and peripheral and central neuraxial blocks. Central neuraxial techniques may be employed for the purposes of providing both primary anaesthesia and postoperative analgesia. Truncal blocks are an effective method of providing analgesia at the donor site and are suitable for catheterisation. The lateral femoral cutaneous nerve block is particularly suitable for this purpose, as it is a sensory nerve only and innervates the lateral thigh region, which is often selected for skin grafts [18].

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Conclusion

Anaesthesiologists have a significant role and responsibility in the treatment of burn patients during surgical procedures in the operating theatre and intensive care unit. Anaesthetists play a pivotal role in the management of various aspects of patient care, including airway management, fluid resuscitation, selection of appropriate agents, haemodynamic support, intravascular access, thermoregulation and determination of optimal ventilation strategies. It is incumbent upon anaesthetists to be cognizant of the pharmacokinetic and pharmacodynamic alterations resulting from burn injuries, and to make the requisite adjustments to the selected agent and dosage. It is incumbent upon anaesthetists to facilitate the multidisciplinary treatment of burn patients by establishing the necessity for communication and collaboration with other members of the team.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
This study was approved by Ankara Bilkent City Hospital Ethics Committee with decision no: E2-23-5042, dated September 27, 2023.

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